LONGWALL DEMONSTRATION IN WESTERN CANADIAN COALS

PHASE 1 - MINE PLANNING & SYSTEMS ENGINEERING

CONTRACT #OSQ82-00107

EXECUTIVE SUMMARY

80 pages
22 figures

Prepared by McIntyre Mines Limited

For Canada Centre for Mineral and Energy Technology (CANMET)

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PREFACE

Considerable resources of high quality coal contained in thick inclined seams are located in Western Canada. Current room and pillar underground mining systems are severely limited in their ability to recover these resources safely and efficiently, reducing the proportion of the resource that can be classified as mineable.

Recent technological advances have enabled longwall installations to successfully operate in seams up to 16 ft thick, inclined at up to 70 degrees. Successful introduction of this technology to Western Canada could substantially improve safety, resource recovery and the competitive position of Canada in export markets. To ensure successful operation, equipment specifications must be based on site specific data.

Smoky River Coal Limited, a wholly owned subsidiary of McIntyre Mines Limited, operates a complex of surface and underground mines in the Smoky River coalfield in West Central Alberta, with capacity to produce some 2.0 million tons of high quality metallurgical coal for market. In 1981, 643 500 tons were obtained from underground mining operations. McIntyre has identified an area of mineable coal at the Smoky River No. 9G Mine suitable for demonstration of longwall mining techniques.

Following general acceptance of a background paper prepared by McIntyre concerning this possibility and circulated to CANMET, Alberta Government agencies, the Coal Association of Canada and the Coal Mining Research Centre, McIntyre submitted a proposal to CANMET to conduct a detailed feasibility study of a demonstration longwall at McIntyre's Smoky River No. 9G Mine. Detailed terms of reference are included in Appendix 2-1.

Concurrent with submission of McIntyre's proposal, CANMET commissioned Montreal Engineering Company to assess the potential for a longwall demonstration in Western Canada. The Montreal Engineering study concluded that the site proposed by McIntyre was appropriate for a meaningful longwall trial to be conducted. Approval to proceed with Phase 1 Mine Planning and Systems Engineering was given by CANMET on September 16 1982.

This report outlines the development of the Smoky River operation, provides data on regional geology and coal reserves, describes current operations and presents a detailed engineering study concerning recovery of coal reserves contained in Seam #4 at McIntyre's Smoky River No. 9G Mine by longwall. If suitable risk sharing agreements can be reached with other interested agencies, and market conditions are favourable, McIntyre would consider developing the 9G-4 Mine for extraction by longwall.

REPORT FORMAT

This report is entitled **Longwall Demonstration in Western Canadian Coals Phase 1 Mine Planning and Systems Engineering.** For convenience a short title, **Longwall Demonstration Phase 1**, is used. Phase 2 would encompass the actual procurement and operation of longwall equipment at the No. 9G-4 Mine.

In the report the term **in place coal** is used to describe unmined coal in its geologic location. **Run-of-mine** coal is used to denote mined coal prior to any form of sizing at the coal preparation plant facility. **Raw coal** is used to denote run of mine coal which has been subjected to sizing prior to processing in the preparation plant. The term **clean coal** denotes coal which has been processed to meet market specifications.

The report has been prepared in Imperial Units, consistent with the company's statistics, and throughout the report, where reference is made to tons of coal, long tons of 2240 pounds are implied.

This executive summary consists of nine sections.

Section 1 Background to the Study briefly describes the development of mining systems in Europe and North America, with particular attention to the application of these systems to Western Canada in general and to McIntyre's Smoky River operations in particular.

Section 2 Smoky River Operations provides a description of the Smoky River operations, including the No. 9G-4 Mine at its current stage of development.

Section 3 Design Considerations addresses the general principles of planning and design for longwall operations. Parameters derived have been used subsequently, to develop detailed mine design and operating sequences.

Section 4 Reserves and Design Parameters addresses in detail the general design considerations discussed in Section 3 and the factors which affect mine design for application in No. 9G-4 Mine. Appropriate parameters have been derived and used to develop the detailed mine planning and systems engineering.

Section 5 Longwall Design for No. 9G-4 Mine undertakes the detailed design for longwall in No. 9G-4 Mine, based on resource data and parameters developed in Section 4. Alternative mining layouts are compared and a recommended layout proposed.

Section 6 Longwall Operations discusses each phase of the longwall operation.

Section 7 Longwall Equipment Tenders discusses preparation of an invitation to tender for the supply of longwall equipment, and assessment of tenders received.

Section 8 Management of a Longwall Demonstration Project discusses management and control of the longwall demonstration project, identifying terms of reference for the Project Steering Committee, recommendations for research and the need for training of supervisory and operating personnel.

Section 9 Economic Evaluation presents an assessment of costs and an economic evaluation of the proposed longwall demonstration project.

Tables and Figures are referenced in the text and appear at the end of each section to which they relate in the order stated.

Appendices where referenced, refer to data supplied with the complete report.

The **Executive Summary** in this volume is preceeded by a summary statement of **Findings, Conclusions and Recommendations** which follow.

FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

FINDINGS AND CONCLUSIONS

Technical

In terms of geological and geotechnical parameters, there are no significant barriers to the successful application of longwall in the target area of No. 9G Mine.

Detailed consideration of the reserves has shown that an appropriate layout for longwall mining can be designed, and that the development work can be undertaken with existing equipment and systems. A machine capable of driving development headings in the more steeply inclined areas of the mine has been identified.

Conservative production performance calculations for development and longwall mining show that both activities can be phased to provide continuing longwall operation.

At the required manpower level of about 150 with overtime estimated at 12%, productivity would average 26 tons of raw coal per manshift at the mine-mouth.

The submission of very detailed tenders for the supply of longwall equipment, including favorable performance guarantees and purchasing arrangements, in response to a site specific enquiry document clearly demonstrates manufacturers support for the technical feasibility of longwall in No. 9G Mine.

Existing services and infrastructure at No. 9G Mine can be readily expanded where necessary to accommodate longwall.

While the project has been evaluated as a demonstration and this feasibility study is based upon the extraction of three longwall panels, in practice if demonstrated to be viable, longwall operations would be continued, and the equipment would be transferred to other areas of the mine. Potential areas for continued longwall operations in No. 9G-4 Mine have been identified.

Economic

Longwall equipment can be procured for installation in the No. 9G Mine at a capital cost of $12.5 million. Based on current mining costs for development and estimated cost for longwall the resulting cost to produce and transport coal to a mine mouth stockpile would be:

Year	$
1	33.53
2	13.46
3	12.96
4	13.53
5	11.64

At the current sales price the longwall demonstration would provide a positive cash flow after the first year of operation and an acceptable net present value. Continued operation of the longwall system, beyond the demonstration phase, would improve the overall economic picture.

However, if longwall were implemented it would displace other production capacity and must achieve the projected production levels throughout the project life both to ensure the required rate of return and to meet market commitments.

Development to prepare the No. 9G Mine for longwall will require significant expenditure in the first year of the project. This is in addition to the capital expenditures already incurred by McIntyre to establish the mine to its present stage of development.

Development of No. 9G-4 Mine for longwall would not be readily converted for extraction by room and pillar methods. Thus, if the longwall system failed to operate to projected output levels there would be a significant risk of production and financial loss.

While a successful longwall at No. 9G Mine would provide an attractive return on investment, the viability of longwall cannot be considered in isolation at a mine currently operating both surface and underground facilities, although it may be prudent to do so for a new mine development. Therefore, before installation of longwall at Smoky River can be contemplated, even as a demonstration, two major factors must be considered:

- Market availability for longwall incremental production.
- Availability of risk capital for the demonstration project.

Whilst both technical and economic considerations are positive, the longwall would be unique in Western Canada. At present no relevant Western Canadian operating experience is available. The involvement of CANMET and other agencies may be essential to minimize the risk to the operator and to share the burden imposed by the requirement for large sums of up-front capital, until the longwall systems' viability is proven.

Present circumstances dictate that, unless markets can be found for the incremental production from longwall, and risk capital can be procured, it is unlikely that the demonstration can proceed at the present time.

As a result of the recent contraction in markets for Smoky River coal and the consequent under-utilization of existing production capacity, the current climate is not favorable for the investment of significant sums of risk capital on a longwall trial. However, the reduction in demand for coal as a result of a recession is not uncommon to the mining industry.

As the economic environment improves, coal production will increase to meet demand, alleviating existing economic and investment constraints. The advantages to be gained from longwall viewed against an improved market would provide a more favourable background for a longwall demonstration.

RECOMMENDATIONS

Although the depressed coal market presents a barrier to the a demonstration longwall at this time, the current situation should not be accorded undue influence or allowed to overshadow the positive benefits that will accrue to the mining industry and research organizations from a demonstration longwall in appropriate circumstances. When the current recession eases and demand for coal improves, the following recommendations should be implemented:

1. CANMET should participate in a joint venture longwall demonstration project in Western Canada. A suitable site for such a project is No. 9G-4 Mine at Smoky River Coal Limited. Three longwall panels could be extracted over a total period of some four and a half years. The panels proposed would enable both the development and production phases of longwall mining to be evaluated in different mining conditions, including gradients up to 30°. The specification of a typical panel would be:

Development system	2-entry
Face length	550 ft
Extracted height	10 ft
Pillar width	120 ft
Direction of mining	Retreat/faces on-dip
Panel run	4800 ft

2. CANMET and other interested agencies should be prepared to invest significant capital to initiate a demonstration project. This would reduce the proponents initial capital expenditure and share the risk associated with the application of a new mining technique in Western Canadian conditions. CANMET and other interested agencies who may make a capital contribution to the project should develop a means by which the expenditure incurred could be recouped if the demonstration proves successful. For example, repayment could be effected by the imposition of a surcharge on each raw ton produced above an agreed break-even production figure.

3. As early as possible following a decision to proceed with the demonstration project, CANMET should form a Steering Committee and Project Management Group. CANMET's representative on each of these groups should be a qualified mining engineer with longwall mining experience. The Steering Committee should confirm the objectives for the program, monitor the performance of the demonstration and ensure that appropriate information is collected and properly disseminated. The Project Management Group should be responsible for the mining operations and research activities, receiving guidance from and reporting to, the Steering Committee.

4. The consideration of other sites is outside the scope of this report. Undoubtedly, benefits could be obtained from a longwall demonstration at other locations, but before alternate sites are considered as candidates, CANMET should require and fund appropriate site specific studies to complement the work presented in this report.

5. A demonstration longwall will produce large volumes of coal and is likely to affect the production plans of any mining company involved. CANMET should assure themselves of the market for coal produced from the longwall for the demonstration period before undertaking any significant capital expenditure on equipment.

6. It is unlikely that a more suitable site than that reviewed in this report will become available in the near term. CANMET should explore with Smoky River Coal Limited and other agencies every possible avenue by which a demonstration may be initiated at this location.

McINTYRE MINES LIMITED

LONGWALL DEMONSTRATION
PHASE 1

EXECUTIVE SUMMARY

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1.0 BACKGROUND TO THE STUDY

HISTORICAL

Until the advent of mechanization in the early 1900's, mining methods were manpower intensive and hazardous. The exhaustion of easily mined shallow reserves forced the exploitation of deeper and more difficult seams and new technology and mining systems were developed to allow efficient and safe production in these conditions. A major step was made during the 1940's when the flexible armoured conveyor was introduced. This development and subsequent powered roof support innovations in the 50's to 70's was the forerunner of mechanical longwall mining which is now employed to extract the major portion of all coal mined underground in Europe. Using longwall, European mines have established enviable safety records, attaining high levels of productivity where mining conditions permit.

In countries where underground coal mining developed later, such as Canada and the US, machinery and mining systems were determined by the large areas of relatively shallow, level-lying reserves too deep for open pit mining that were available for exploitation. Mechanized room and pillar systems were developed to replace hand mining systems and these are both highly productive and safe in suitable conditions.

Currently reserves efficiently exploitable by room and pillar are becoming depleted and longwall systems are being introduced.

LONGWALL EXPERIENCE

When the Smoky River mine was initially developed, production was planned from two underground mines using longwall with development work by continuous miners. In October 1970 the first longwall went into operation in No. 5 Mine 503 District and in January 1971 the second longwall face commenced operation in No. 2 Mine 205 district. Due to operational difficulties both longwall faces were stopped in July 1971. To meet contractual commitments surface mining operations were developed at No. 8 Mine and room and pillar extended underground. The reasons for longwall failure are poorly documented but it is certain that the following problems contributed to the failure:

- Inappropriate roof support design with inherent deficiencies.
- Poor roof control on the face.
- Floor penetration.
- Delays in equipping the face.
- Effects of adjacent mining operations.
- Diversion of longwall manpower to other activities.
- Ventilation problems.

Development of shield and chock shield support since 1971 has significantly enhanced the mechanical strength, stability and operational capability of longwall systems. Current shield supports have characteristics that overcome most of the problems encountered in 1970/71.

LONGWALL DEMONSTRATION

Underground mining operations are currently concentrated in Seam #4 and employ the room and pillar system. Mine boundaries are determined by locations at which seam inclination exceeds 15°.

In the initial stage of planning for No. 9G Mine in 1981, assessment of geological and geotechnical data indicated that the mine could be planned for longwall mining. The advantages to be gained include:

- Improved coal recovery by mining steeper grades.
- Improved productivity and enhanced competitive market position.
- Improved safety through the provision of a controlled mining environment.

As the operator, McIntyre would certainly benefit from the installation of a longwall system, but benefits would also accrue to other Canadian operators or potential operators. Since the installation at Smoky River would be unique in Western Canada it would provide an opportunity to conduct meaningful research into mining problems and provide a data base for longwall systems at other Western Canadian locations.

Accordingly, McIntyre elected to enter into discussions with government and other agencies to determine how a longwall demonstration project could be organized and funded as a co-operative venture. To initiate proceedings, McIntyre issued a background paper and held discussions with CANMET personnel in Ottawa and with Alberta Government agencies. The proposal was sent to the Coal Association of Canada and the Coal Mining Research Centre in Alberta for review.

Following general acceptance of the background paper, McIntyre submitted a proposal to CANMET to conduct a detailed study of a demonstration longwall at the Smoky River No. 9G-4 Mine.

Concurrent with submission of McIntyre's proposal, CANMET commissioned Montreal Engineering Company to assess the potential for a longwall demonstration in Western Canada. The Montreal Engineering study concluded that in general the site proposed by McIntyre was appropriate for a meaningful longwall trial to be conducted. Approval to proceed with this design and engineering study was given by CANMET on September 16 1982.

2.0 SMOKY RIVER OPERATIONS

The Smoky River coalfield is located some 225 miles west of Edmonton approximately 110 miles by road northwest of the town of Hinton, on the route of the Alberta Resources Railway (Figure 2-1). The production facilities at Smoky River have been established for more than ten years and have an annual capacity in excess of 2 million clean tons. More than 14 million tons of metallurgical coal have been produced and shipped since 1970. The facilities are operated by an experienced management and work force with a demonstrated production capability.

The proposed site of the longwall demonstration, No. 9G-4 Mine, is at present maintained on a care and maintenance basis. Depending upon decisions on funding and timing for a demonstration the mine could be reactivated for longwall, or room and pillar mining.

EXPLORATION AND DEVELOPMENT

Regional Geology

The coal in the Smoky River coalfield was deposited in a succession of interbedded marine and alluvial sandstones, siltstones and mudstones during the Lower Cretaceous Period. Subsequently these strata were tectonically deformed by folding and overthrusting along a northwesterly trending front. After general uplift the area was dissected by glacial and stream erosion along north-easterly directed valleys leaving a rugged relief of nearly 4000 ft. The general setting of this area is illustrated in Figure 2-3.

Mining Areas

The Smoky River coalfield is divided into mine areas by geologic structures and deeply eroded river valleys (Figure 2-3).

Mining operations to date have been restricted to the fault slice between the Muskeg and Mason Thrusts. Other fault blocks, overthrust from the southwest, bring the coal bearing strata above the Smoky River Valley bottom.

Development

Construction at Smoky River was essentially completed in the third quarter of 1970 and underground development in No. 2 Mine and No. 5 Mine started in 1969 based on longwall. In 1971 longwall operations were replaced by room and pillar. To alleviate the shortfall in underground production No. 8 Surface Mine was started.

In 1973 No. 5 Mine closed and production from No. 8 Surface Mine was increased. No. 9 Surface Mine was developed to replace production from No. 8 Mine and reached rated production during 1974.

In 1979 operations resumed in No. 5 Mine (Seam #4) and a new underground mine No. 9A (Seam #4) was opened off the highwall of No. 9 Surface Mine. Production increased from less than 1 million tons in 1979 to a record high of almost 2.1 million tons in 1981 to meet market demands.

Table 2-1 summarizes raw and clean coal production from 1970 through 1981 showing the proportions of raw coal mined by surface and underground methods.

Surface Mines

Presently there is the one surface mine at Smoky River, No. 9 Mine. The mining method is conventional truck and shovel. Coal is trucked from No. 9 Mine to the Sheep Creek breaker station located approximately 5 miles away. From the breaker station the coal is conveyed to the coal preparation plant by conveyor. The mine has fully equipped maintenance facilities centrally located approximately one mile east of the present open pit.

Underground Mines

There are presently two underground mines developed in Seam #4, No. 9G-4 and No. 9A-4 Mines. Coal from these mines is loaded into trucks and transported some 5.5 miles to the Sheep Creek breaker station. The locations of current underground mines is shown in Figure 2-4.

The entrances to No. 9G-4 Mine are located approximately 0.8 miles to the northeast of the open pit workshop area (Figure 2-5). Access to Seam #4 is from two cross-measure drifts some 1100 ft long. A description of No. 9G-4 Mine and mining operations is provided later.

The entrances to No. 9A-4 mine are located approximately 0.5 miles due west of the open pit workshop area. The seam thickness varies from 19.5 to 22 ft with the working section being the top 10 to 12 ft of the seam. The mine has been developed a distance of 5000 ft to an arbitrary mine boundary. Retreat pillaring operations are now underway and mine reserves within the present mine boundaries will be exhausted in the last quarter of 1983.

Potential Underground Mines

Three potential mines exploitable by current underground methods have been identified, these are No. 9B-4 Mine, No. 9C-4 Mine and No. 7 Mine (Figure 2-6).

No. 9B-4 Mine area is located approximately 1.5 miles west of the open pit workshop area and No. 9C-4 Mine area is an extension of No. 9B-4 Mine. Total recoverable reserves from both mines are estimated at 6.7 million tons.

No. 7 Mine is located in a virgin area and significant capital expenditure would be required to establish the necessary infrastructure and transportation corridors. Exploration activity conducted in 1981 identified proven reserves of 10 million tons of coal in Seam #4 and 5 million tons in Seam #3. The seams are generally flat lying under relatively shallow cover and are considered of high potential for underground mining.

PRINCIPAL SURFACE FACILITIES

The principal surface facilities are the raw coal transportation system and the main service complex shown on Figure 2-7.

The main components of the raw coal transportation system are the tunnel conveyor system and a fleet of Caterpillar 773 and 777 trucks.

The tunnelway transports, or will transport, coal from both surface and underground mines.

The main service complex facilities include the coal preparation plant, main office, deployment centre, mine dry, workshops and warehouse, all of which have sufficient capacity to support the level of output envisaged for the Smoky River operation.

THE NO. 9G-4 MINE

Surface Facilities

The site of the proposed longwall demonstration is No. 9G-4 Mine. The mine portals are located in mountainous terrain on the north side of Sheep Creek approximately 7 miles from its junction with the Smoky River. The main surface workshop and facilities area is located approximately 0.8 miles to the southwest (Figure 2-5).

A 60 ft wide all-weather mine road extends from the service complex/ preparation plant to the No. 9 Surface Mine area. A roadway of similar standard has been constructed from No. 9G Mine to intersect this road as shown on Figure 2-5. The road system can accommodate the transportation of large and heavy items of equipment.

Established surface facilities at the mine are comprehensive and, when combined with the adjacent surface mine workshop facilities, are adequate to support longwall development, operations and research.

The existing surface facilities (Figure 2-8) include:

- A combined bathhouse, change rooms, lamproom, manpower deployment and office facility. The facilities can accommodate a total of 150 persons. Office facilities are provided for senior management, supervisory and maintenance staff.

- Water storage, softening and heating facilities of adequate capacity to service the bathhouse complex and workshops.

- Propane storage of adequate capacity to provide heating to the bathhouse complex, workshops and mine air heating system.

- An electrical substation and distribution complex to provide power for both surface and underground operations.

- A two-bay service building suitably equipped for routine servicing and maintenance of diesel powered supply vehicles.

- A three-bay service building suitably equipped to allow routine servicing and maintenance of electrical and mechanical equipment in separate bays. The third bay is used as a covered storage area for equipment spares and materials such as lubrication oils and greases.

- A portal building located adjacent to the main conveyor drive to accommodate the conveyor attendant, allow searches for contraband materials and register personnel in the mine.

- The main trunk conveyor drive and delivery unit which discharges coal to an 8000 ton capacity stockpile.

- Main ventilating fans, airlock and access for supplies. The ventilation facility is so constructed that the capacity of the system can be readily increased by the installation of additional fan units or a larger capacity single unit.

- An area adjacent to the mine portals designated as a stockyard for items of equipment routinely consumed in mining operations, i.e. timbers, roof bolts, etc. The stockyard is designed to allow unobstructed access to stocked items for both trucks and underground supply vehicles.

- A propane-fired air-heater installed between the two mine entrances to ensure that the air temperature in the underground mine remains at a reasonable level and to prevent icing conditions in the main intake. Appropriate flame monitoring protection devices are incorporated in the heater control systems.

- An area available to accept large stores items for trans-shipment to supplies vehicles for transportation underground.

Mine Services

The main power supply is obtained from a substation at the Milner Plant. In the event of a shutdown of the power station power requirements can be met by importing power from the grid system. Power is distributed by overhead line to the mines at 25 kV. A simplified schematic diagram is shown in Figure 2-9. At the mines voltage is stepped down to 6.6 kV for underground distribution and to 550 volts for surface distribution and utilization. Surface lighting and office power supplies are obtained from a separate transformer source. Where continuity of supply is essential as for firefighting pumps a separate stand-by diesel generator is provided.

For communication purposes an automatic electronic switchboard and telephone system has recently been installed at the main office. Communication with the No. 9G-4 Mine is achieved through a 100 channel microwave link.

Staff vehicles are equipped with mobile radios. To improve reporting and recording procedures and assist in the resolution of production problems a central control room has been established.

An adequate water supply is available from wells and from within the mine for dust suppression, firefighting and bathing facilities.

Propane storage tanks and vapourizing equipment of adequate capacity to satisfy the total anticipated demand are installed, enclosed in a locked compound and surrounded by safety berms at mine surface.

The equipment fleet for loading and transporting coal from stockpiles operates under the control of the surface mine manager. Fleet capacity when operating from No. 9 Surface Mine and No. 9A and No. 9G Underground Mines is in excess of 8000 tons daily. No problems of maintaining stockpile clearance are anticipated. The existing fleet of roadway maintenance equipment will be retained and no difficulties are anticipated.

First aid facilities are housed in the administrative building and include treatment and rehabilitation areas. An ambulance service is provided and trained personnel man the facility on a continuous basis.

In addition to the mining operations group an engineering section provides services such as ventilation measurement and control, dust sampling, surveying, etc. These services will be continued and where necessary additional support staff will be provided.

Current Status

At No. 9G-4 Mine two cross-measure drifts supported by steel arches have been driven to intersect Seam #4. The drifts are 1100 feet long and dip at 7°. One drift is used as an intake airway and accommodates the main trunk conveyor system. The second drift is used as a return airway and provides access for material and supplies. A substantial airlock has been constructed and accommodation for the main ventilation systems is provided.

From the point of intersection with the coal seam further development has taken place in-seam with roof support by roof bolting. At the point of intersection of the coal seam and access drifts there is a change of gradient from 7° dipping to 12° rising. This forms a natural low point in the mine and a water sump and pumping station has been constructed adjacent to this location. Any water inflow from Seam #10 and inbye workings will be directed to this sump area and pumped to the surface.

Development within the mine has been conducted with conventional room and pillar mining equipment and the extent of current development is shown in Figure 2-10.

Roadways 20 ft wide by 10 ft high spaced at 110 ft centre to centre have been driven. Where possible, crosscuts at 200 ft centres have been constructed at 90° to the development roadways to form square junctions. This has reduced the size of junctions and consequently the area of roof to be supported. The pillars of coal left in this configuration are capable of providing adequate support to the strata above the seam.

Roof support is achieved using roof bolting equipment. Square wire mesh supported by the roof bolt plates covers the total exposed roof area. Side support is achieved with wooden props and planks.

In order to assess the likely conditions along a typical face-line Roadway A was driven approximately 600 ft (Figure 2-10). In this section of roadway:

- Alternative methods of supporting the roadway sides using wooden and epoxy resin dowels were tested.
- A site for testing floor strengths (to be conducted by the Coal Mining Research Centre) was prepared by extracting the full seam section to allow floor strength tests at various horizons in the coal seam.

- Core samples of the immediate strata above and below the coal seam were obtained for testing by Seegmiller International.

Before production was suspended at No. 9G Mine, following a reduction in market demand, three sets of continuous mining equipment were in use. At present the mine is being operated on a 'care and maintenance' basis. Ventilation and pumping are maintained and, where necessary, roadway repairs are effected to ensure that the mine can readily be returned to production status.

TABLE 2-1

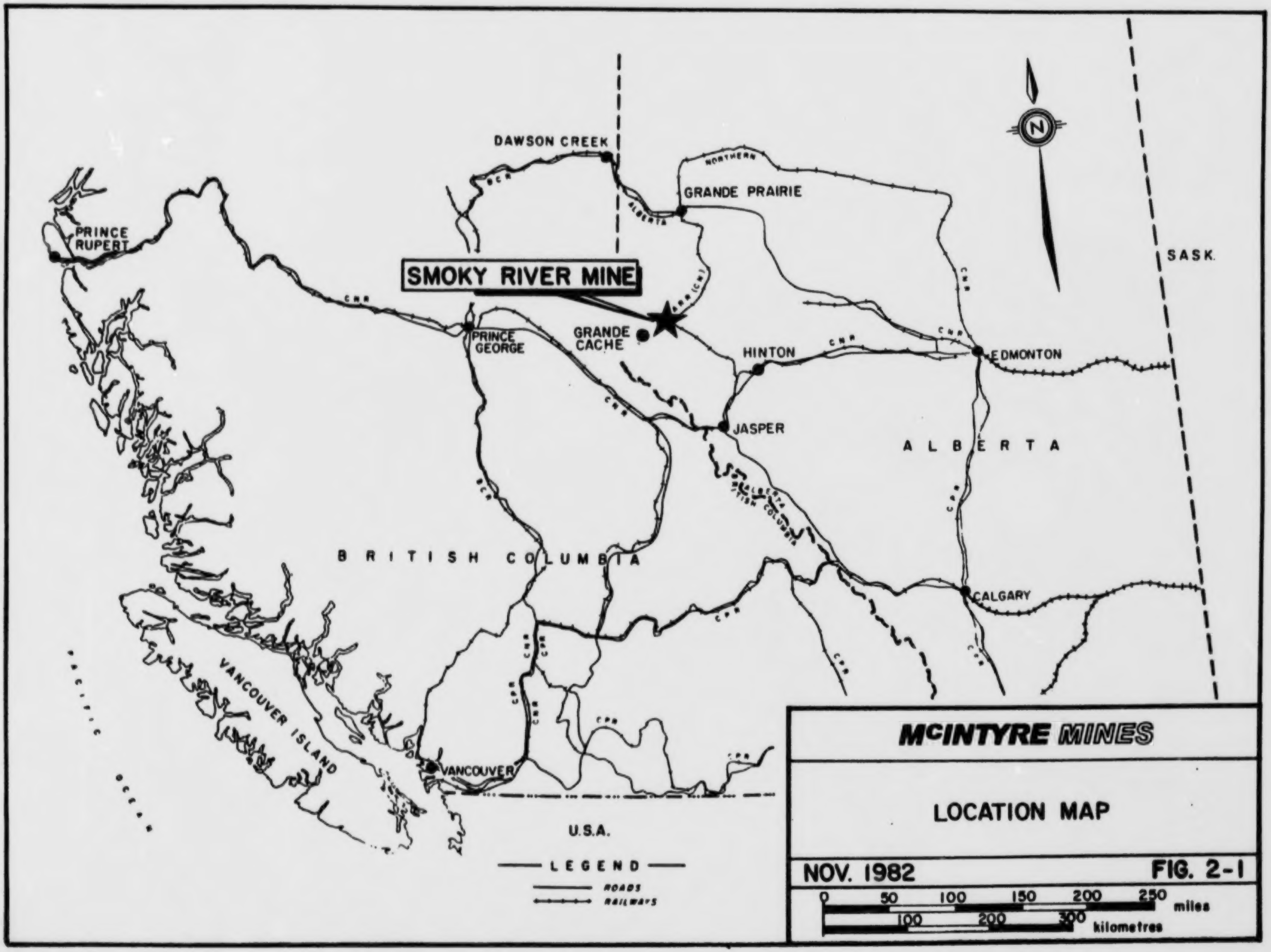
McINTYRE MINES LIMITED

TOTAL PRODUCTION BY SOURCE

	RAW COAL (Thousands of Long Tons)	CLEAN COAL (Thousands of Long Tons)	UNDERGROUND (%)**	SURFACE (%)**
1970	977	420*	100	0
1971	1,993	1,178	82	18
1972	2,533	1,566	58	42
1973	2,087	1,442	39	61
1974	2,358	1,528	32	68
1975	2,588	1,680	30	70
1976	3,162	1,865	35	65
1977	2,944	1,740	43	57
1978	2,131	1,316	58	42
1979	1,755	1,044	64	36
1980	2,329	1,470	47	53
1981	3,108	2,076	31	69

* Excludes coal processed through temporary cleaning plant.

** Raw coal basis.

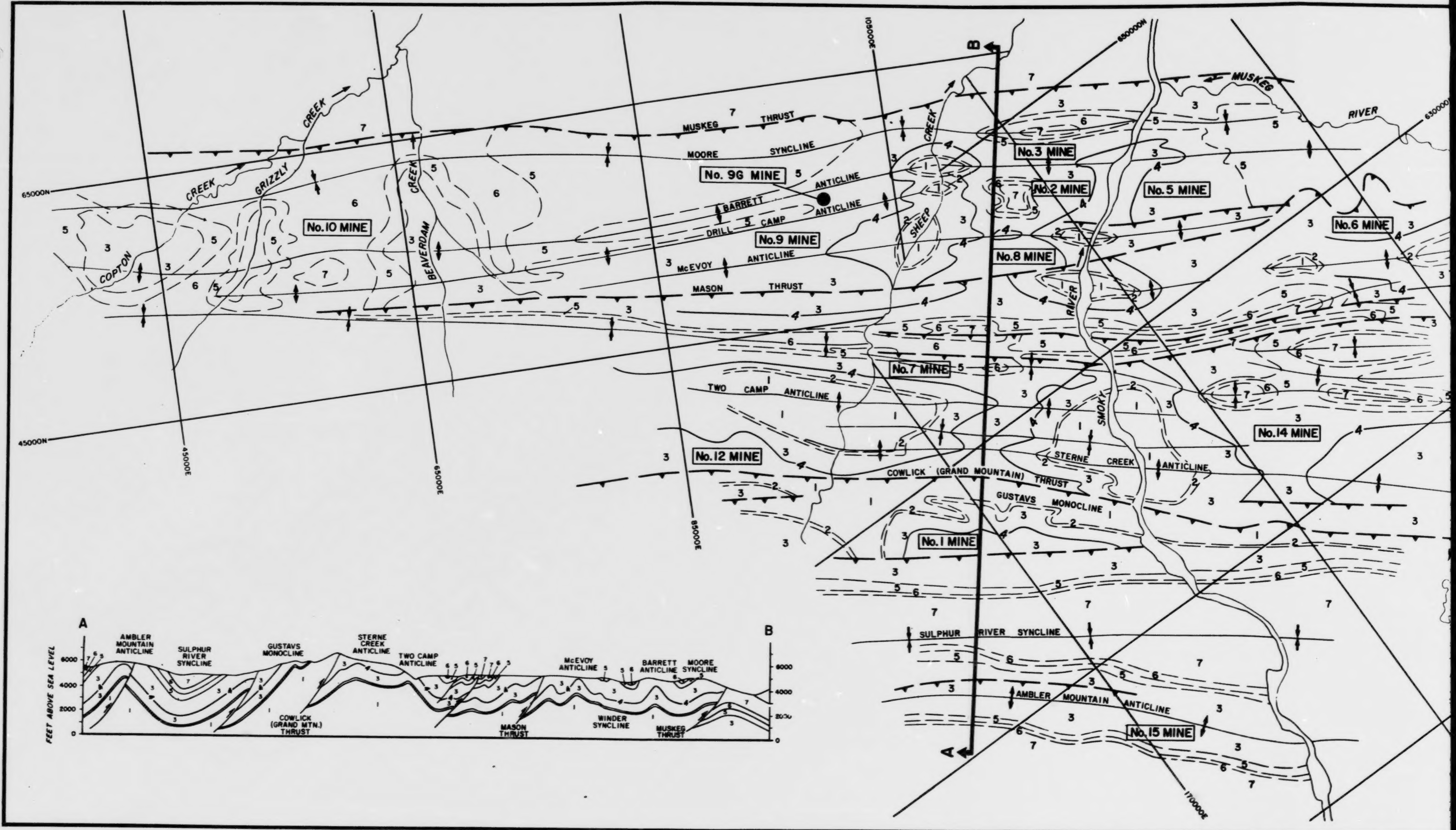

DAWSON CREEK
GRANDE PRAIRIE
NORTHERN
ALBERTA
PRINCE RUPERT
SMOKY RIVER MINE
GRANDE CACHE
PRINCE GEORGE
HINTON
JASPER
EDMONTON
CALGARY
SASK.
ALBERTA
BRITISH COLUMBIA
VANCOUVER ISLAND
VANCOUVER
PACIFIC OCEAN
U.S.A.
CNR
CPR
BCR
N
LEGEND
ROADS
RAILWAYS
0 50 100 150 200 250 miles
100 200 300 kilometres

McINTYRE MINES

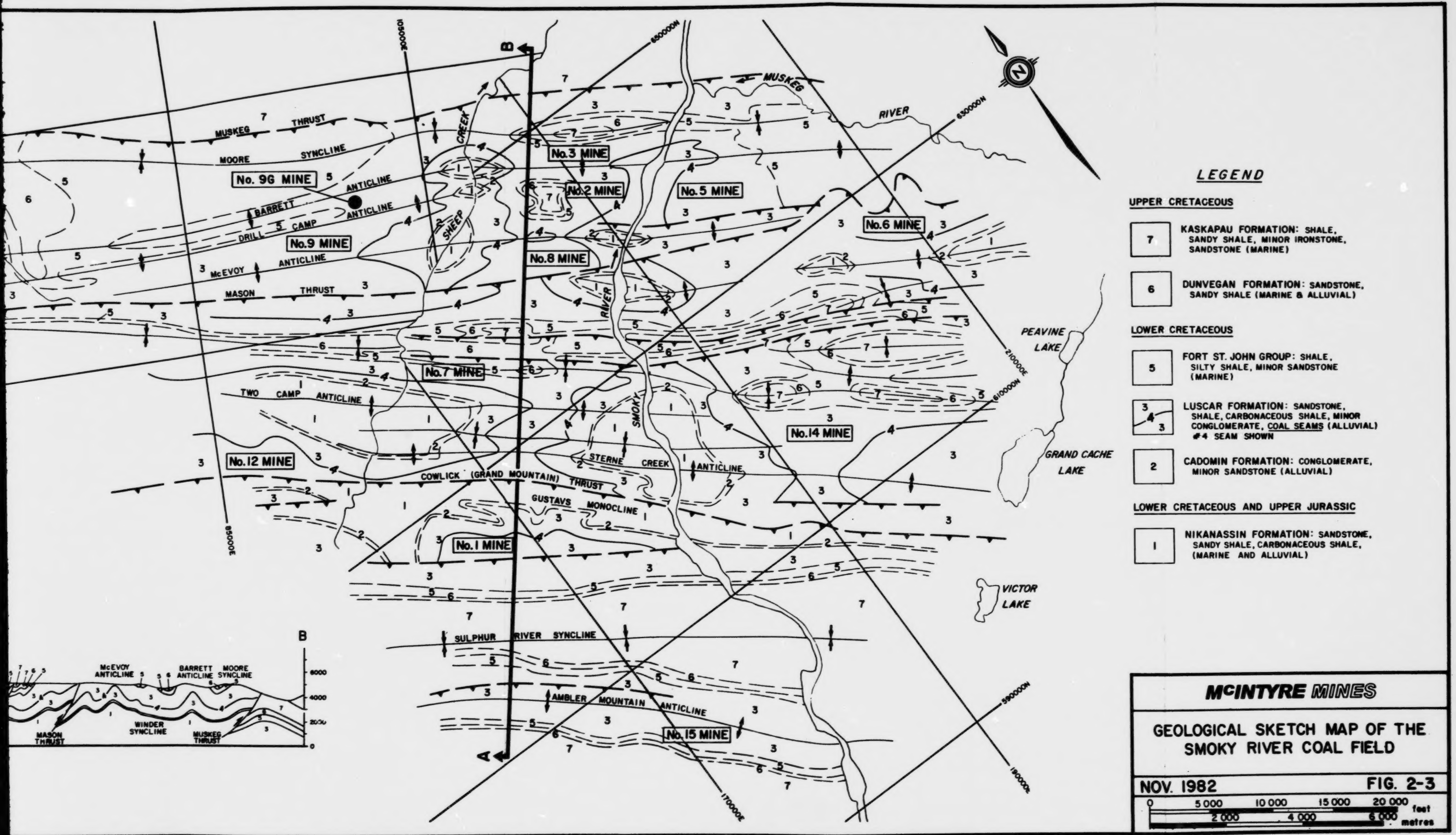
LOCATION MAP

NOV. 1982

FIG. 2-1



B
A
650000N
630000N
105000E
65000N
45000N
45000E
65000E
85000E
170000E
MUSKEG THRUST
MUSKEG RIVER
MOORE SYNCLINE
GRIZZLY CREEK
COPTON CREEK
BEAVERDAM CREEK
SHEEP CREEK
SMOKY RIVER
No. 9G MINE
No. 10 MINE
No. 9 MINE
No. 3 MINE
No. 2 MINE
No. 5 MINE
No. 6 MINE
No. 8 MINE
No. 7 MINE
No. 12 MINE
No. 14 MINE
No. 1 MINE
No. 15 MINE
BARRETT ANTICLINE
DRILL CAMP ANTICLINE
McEVOY ANTICLINE
MASON THRUST
TWO CAMP ANTICLINE
STERNE CREEK ANTICLINE
COWLICK (GRAND MOUNTAIN) THRUST
GUSTAVS MONOCLINE
SULPHUR RIVER SYNCLINE
AMBLER MOUNTAIN ANTICLINE
FEET ABOVE SEA LEVEL
6000
4000
2000
0
AMBLER MOUNTAIN ANTICLINE
SULPHUR RIVER SYNCLINE
GUSTAVS MONOCLINE
STERNE CREEK ANTICLINE
TWO CAMP ANTICLINE
McEVOY ANTICLINE
BARRETT ANTICLINE
MOORE SYNCLINE
COWLICK (GRAND MTN.) THRUST
MASON THRUST
WINDER SYNCLINE
MUSKEG THRUST


B
A
650000N
630000N
610000N
590000N
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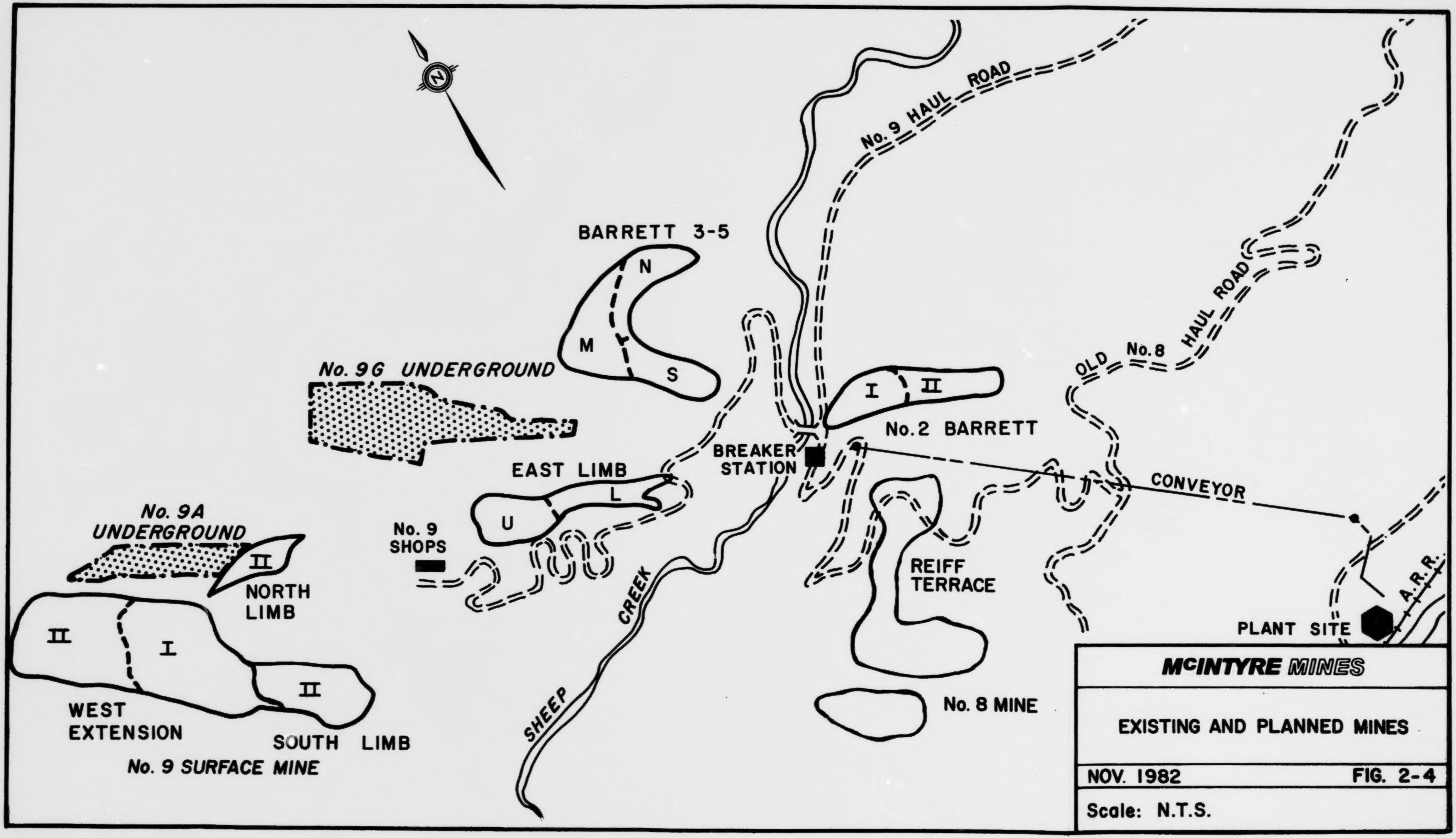
190000E
210000E
N
MUSKEG THRUST
MUSKEG RIVER
MOORE SYNCLINE
BARRETT ANTICLINE
ANTICLINE
DRILL CAMP ANTICLINE
McEVOY ANTICLINE
MASON THRUST
TWO CAMP ANTICLINE
COWLICK (GRAND MOUNTAIN) THRUST
STERNE CREEK ANTICLINE
GUSTAVS MONOCLINE
SULPHUR RIVER SYNCLINE
AMBLER MOUNTAIN ANTICLINE
SHEEP CREEK
SMOKY RIVER
No. 9G MINE
No.9 MINE
No.3 MINE
No.2 MINE
No.5 MINE
No.6 MINE
No.8 MINE
No.7 MINE
No.14 MINE
No.12 MINE
No.1 MINE
No.15 MINE
PEAVINE LAKE
GRAND CACHE LAKE
VICTOR LAKE
McEVOY ANTICLINE
BARRETT ANTICLINE
MOORE SYNCLINE
WINDER SYNCLINE
MASON THRUST
MUSKEG THRUST
6000
4000
2000
0
LEGEND
UPPER CRETACEOUS
7 KASKAPAU FORMATION: SHALE, SANDY SHALE, MINOR IRONSTONE, SANDSTONE (MARINE)
6 DUNVEGAN FORMATION: SANDSTONE, SANDY SHALE (MARINE & ALLUVIAL)
LOWER CRETACEOUS
5 FORT ST. JOHN GROUP: SHALE, SILTY SHALE, MINOR SANDSTONE (MARINE)
3 4 3 LUSCAR FORMATION: SANDSTONE, SHALE, CARBONACEOUS SHALE, MINOR CONGLOMERATE, COAL SEAMS (ALLUVIAL) #4 SEAM SHOWN
2 CADOMIN FORMATION: CONGLOMERATE, MINOR SANDSTONE (ALLUVIAL)
LOWER CRETACEOUS AND UPPER JURASSIC
1 NIKANASSIN FORMATION: SANDSTONE, SANDY SHALE, CARBONACEOUS SHALE, (MARINE AND ALLUVIAL)
0
5 000
10 000
15 000
20 000
feet
2 000
4 000
6 000
metres

McINTYRE MINES

GEOLOGICAL SKETCH MAP OF THE SMOKY RIVER COAL FIELD

NOV. 1982

FIG. 2-3


N
No. 9 HAUL ROAD
BARRETT 3-5
N
M
S
No. 9G UNDERGROUND
I
II
No. 2 BARRETT
BREAKER STATION
OLD No. 8 HAUL ROAD
CONVEYOR
EAST LIMB
L
U
No. 9A UNDERGROUND
II
NORTH LIMB
No. 9 SHOPS
SHEEP CREEK
REIFF TERRACE
A.R.R.
PLANT SITE
II
I
II
WEST EXTENSION
SOUTH LIMB
No. 9 SURFACE MINE
No. 8 MINE

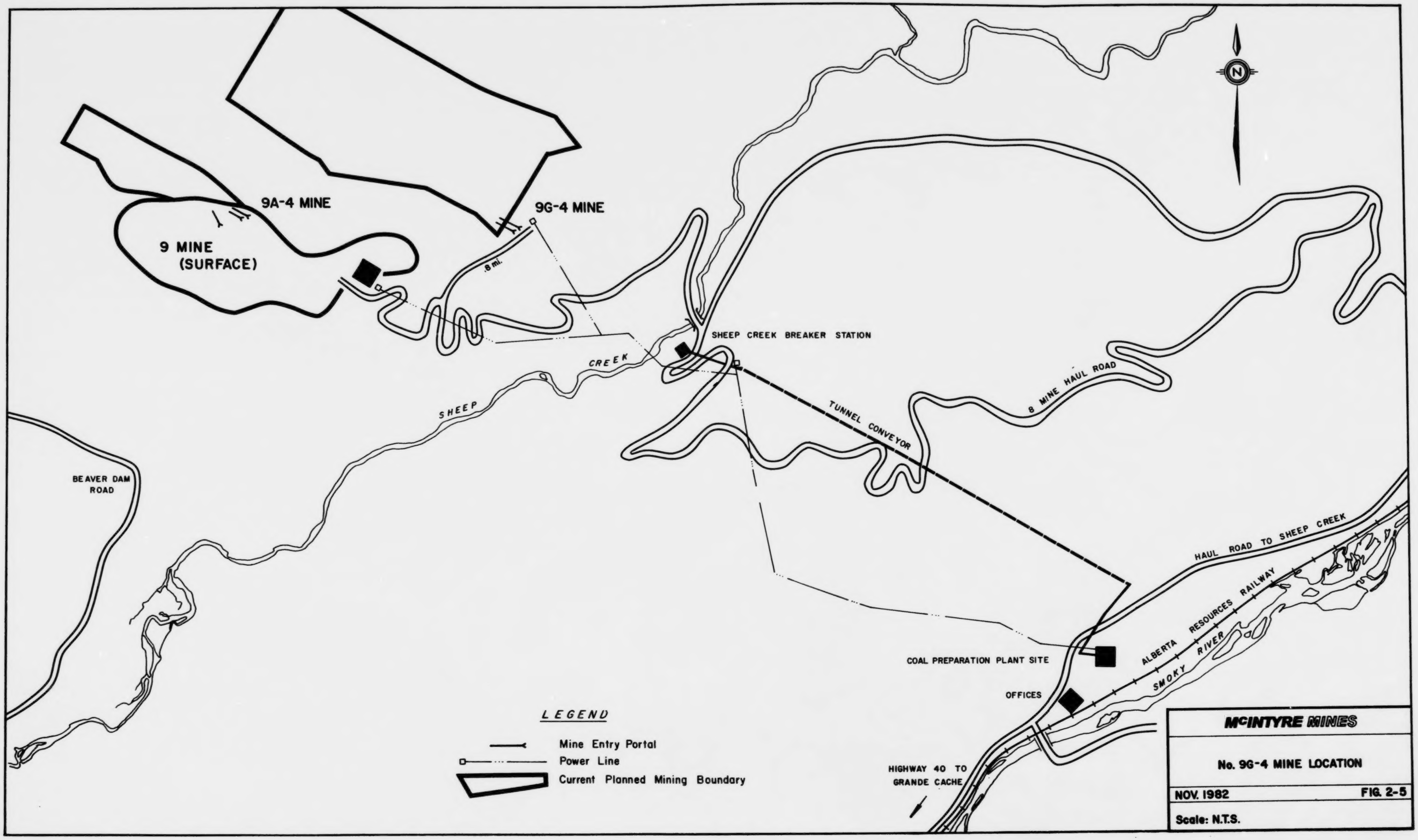
McINTYRE MINES

EXISTING AND PLANNED MINES

NOV. 1982

FIG. 2-4

Scale: N.T.S.


N
9A-4 MINE
9G-4 MINE
9 MINE (SURFACE)
.8 mi.
SHEEP CREEK BREAKER STATION
SHEEP CREEK
TUNNEL CONVEYOR
8 MINE HAUL ROAD
BEAVER DAM ROAD
HAUL ROAD TO SHEEP CREEK
ALBERTA RESOURCES RAILWAY
SMOKY RIVER
COAL PREPARATION PLANT SITE
OFFICES
HIGHWAY 40 TO GRANDE CACHE
LEGEND
Mine Entry Portal
Power Line
Current Planned Mining Boundary

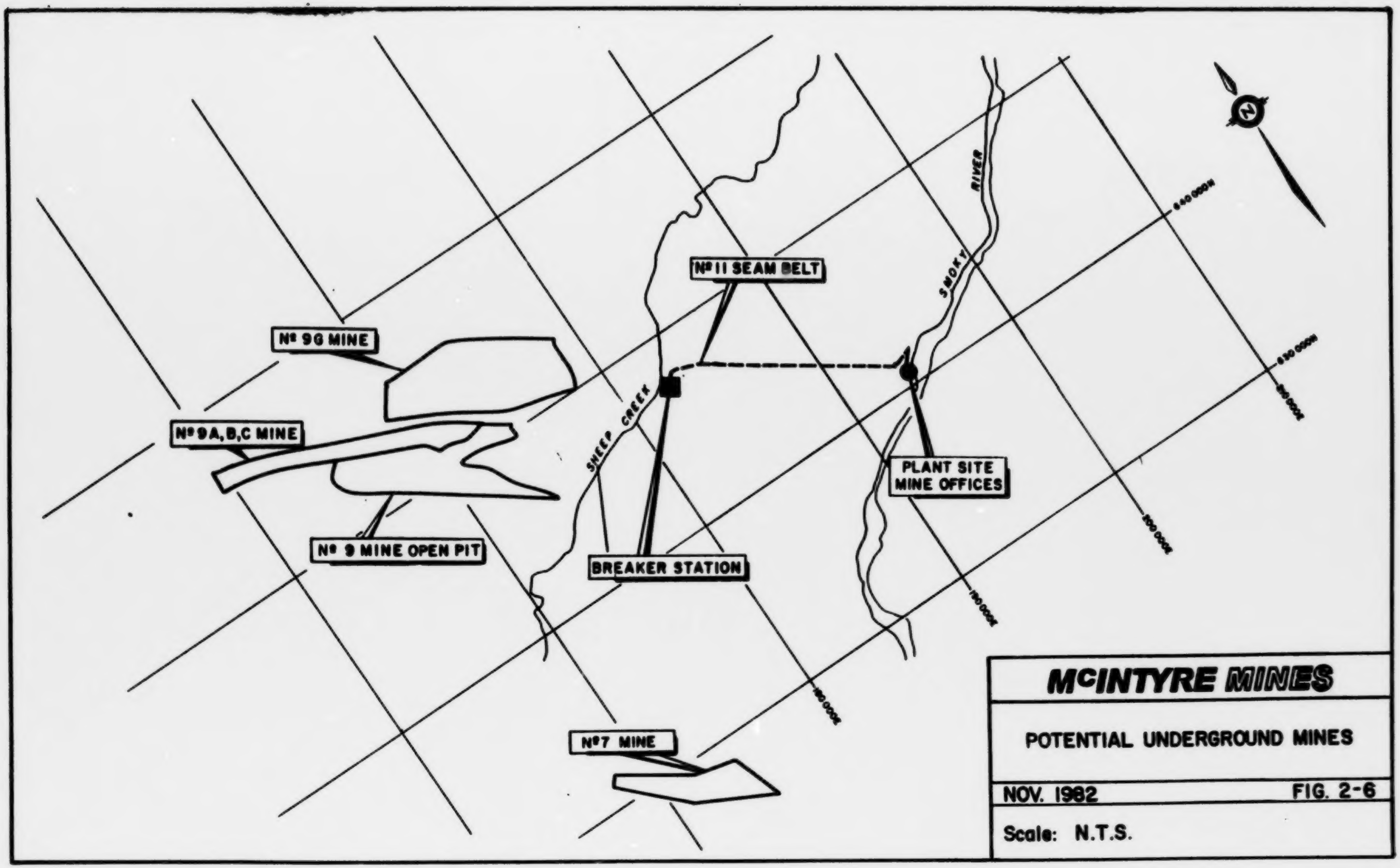
McINTYRE MINES

No. 9G-4 MINE LOCATION

NOV. 1982

FIG. 2-5

Scale: N.T.S.


N
640 000N
630 000N
210 000E
200 000E
190 000E
180 000E
SMOKY RIVER
SHEEP CREEK
Nº 11 SEAM BELT
PLANT SITE
MINE OFFICES
BREAKER STATION
Nº 9G MINE
Nº 9A, B, C MINE
Nº 9 MINE OPEN PIT
Nº7 MINE

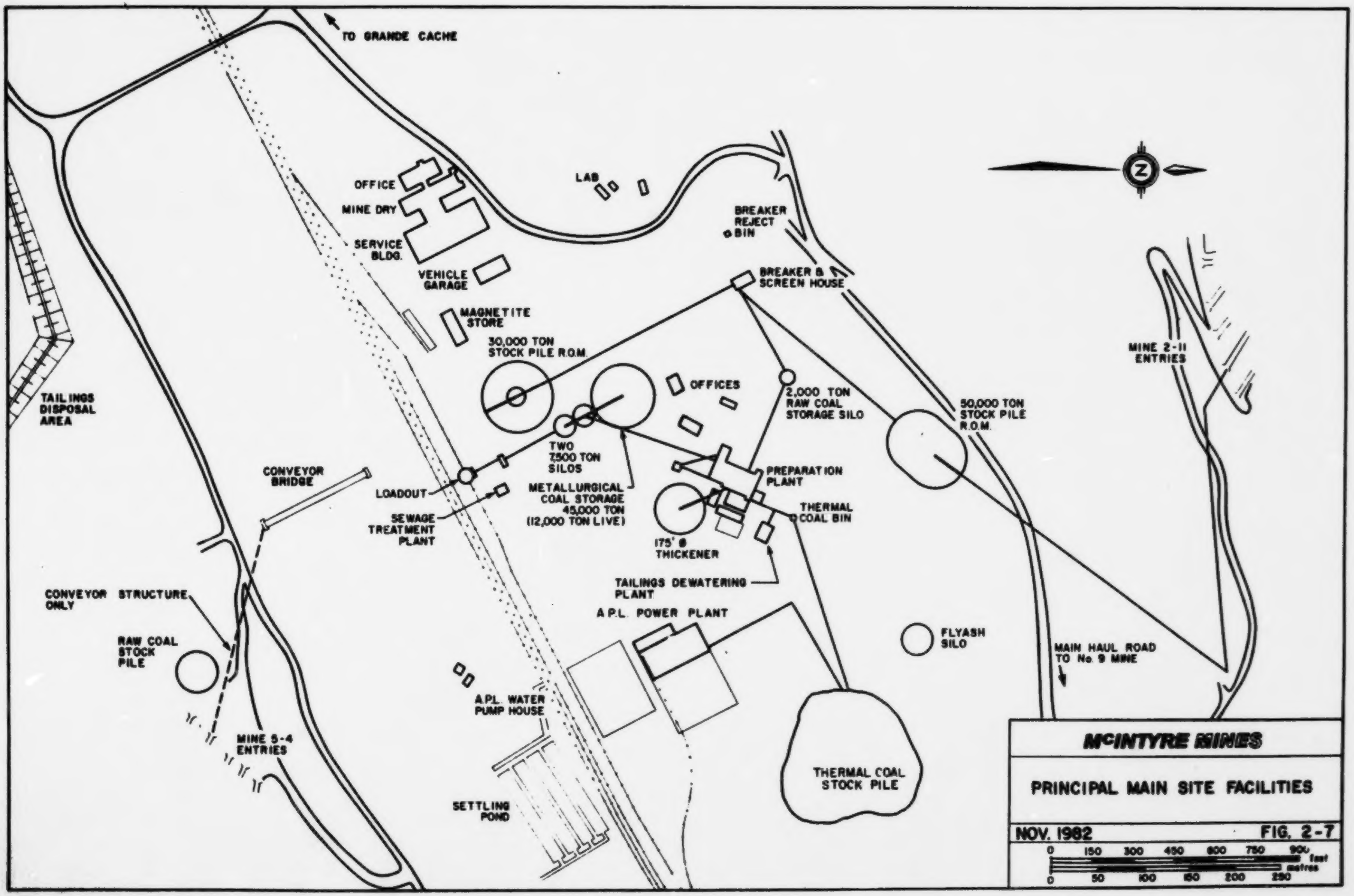
McINTYRE MINES

POTENTIAL UNDERGROUND MINES

NOV. 1982

FIG. 2-6

Scale: N.T.S.



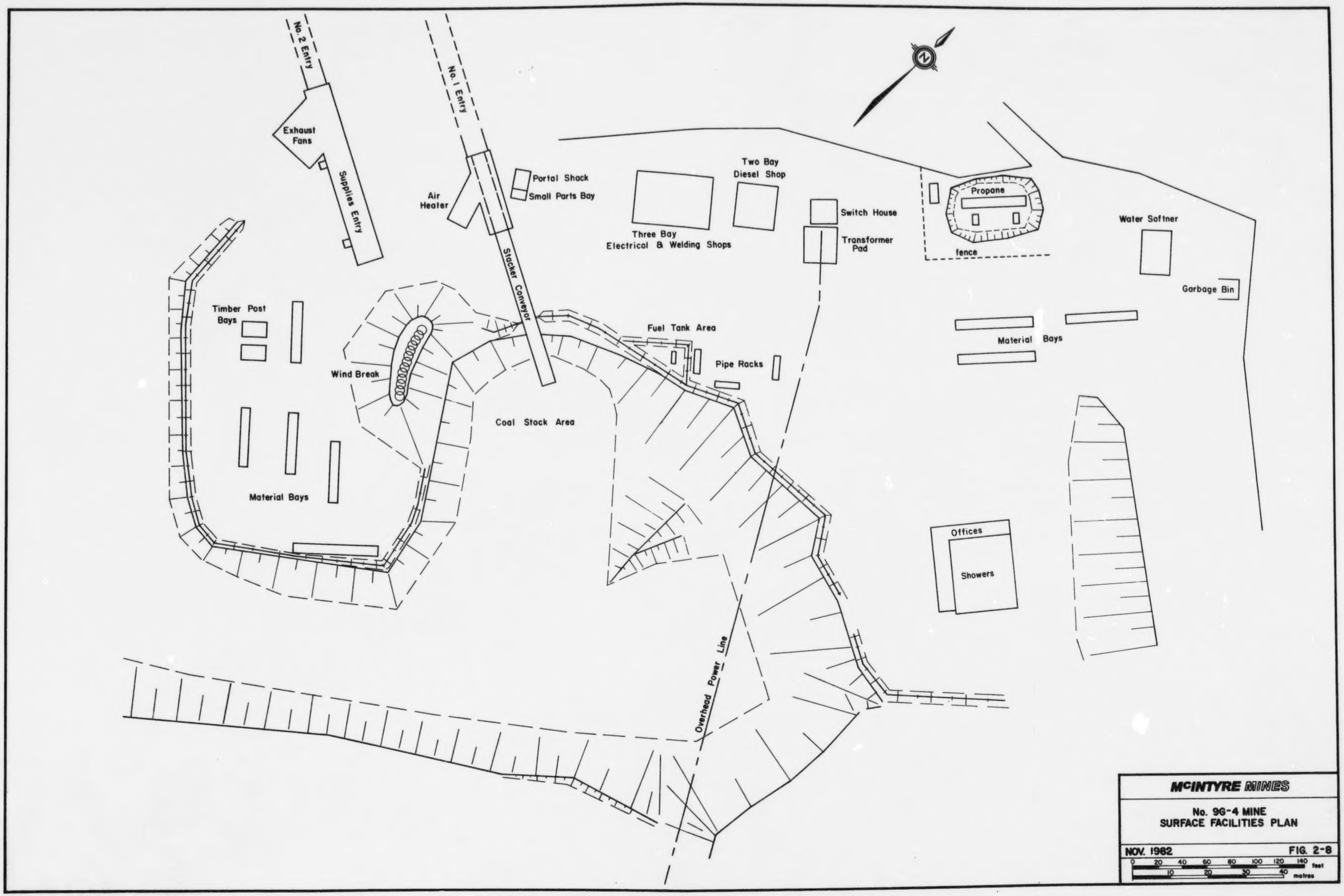
McINTYRE MINES

PRINCIPAL MAIN SITE FACILITIES

NOV. 1982

FIG. 2-7

TO GRANDE CACHE
OFFICE
MINE DRY
SERVICE BLDG.
VEHICLE GARAGE
MAGNETITE STORE
LAB
BREAKER REJECT BIN
BREAKER & SCREEN HOUSE
MINE 2-11 ENTRIES
30,000 TON STOCK PILE R.O.M.
OFFICES
2,000 TON RAW COAL STORAGE SILO
50,000 TON STOCK PILE R.O.M.
TAILINGS DISPOSAL AREA
CONVEYOR BRIDGE
TWO 7,500 TON SILOS
LOADOUT
METALLURGICAL COAL STORAGE 45,000 TON (12,000 TON LIVE)
PREPARATION PLANT
THERMAL COAL BIN
SEWAGE TREATMENT PLANT
175' Ø THICKENER
TAILINGS DEWATERING PLANT
CONVEYOR STRUCTURE ONLY
A.P.L. POWER PLANT
RAW COAL STOCK PILE
FLYASH SILO
MAIN HAUL ROAD TO No. 9 MINE
A.P.L. WATER PUMP HOUSE
MINE 5-4 ENTRIES
THERMAL COAL STOCK PILE
SETTLING POND
Z
0 150 300 450 600 750 900 feet
0 50 100 150 200 250 metres

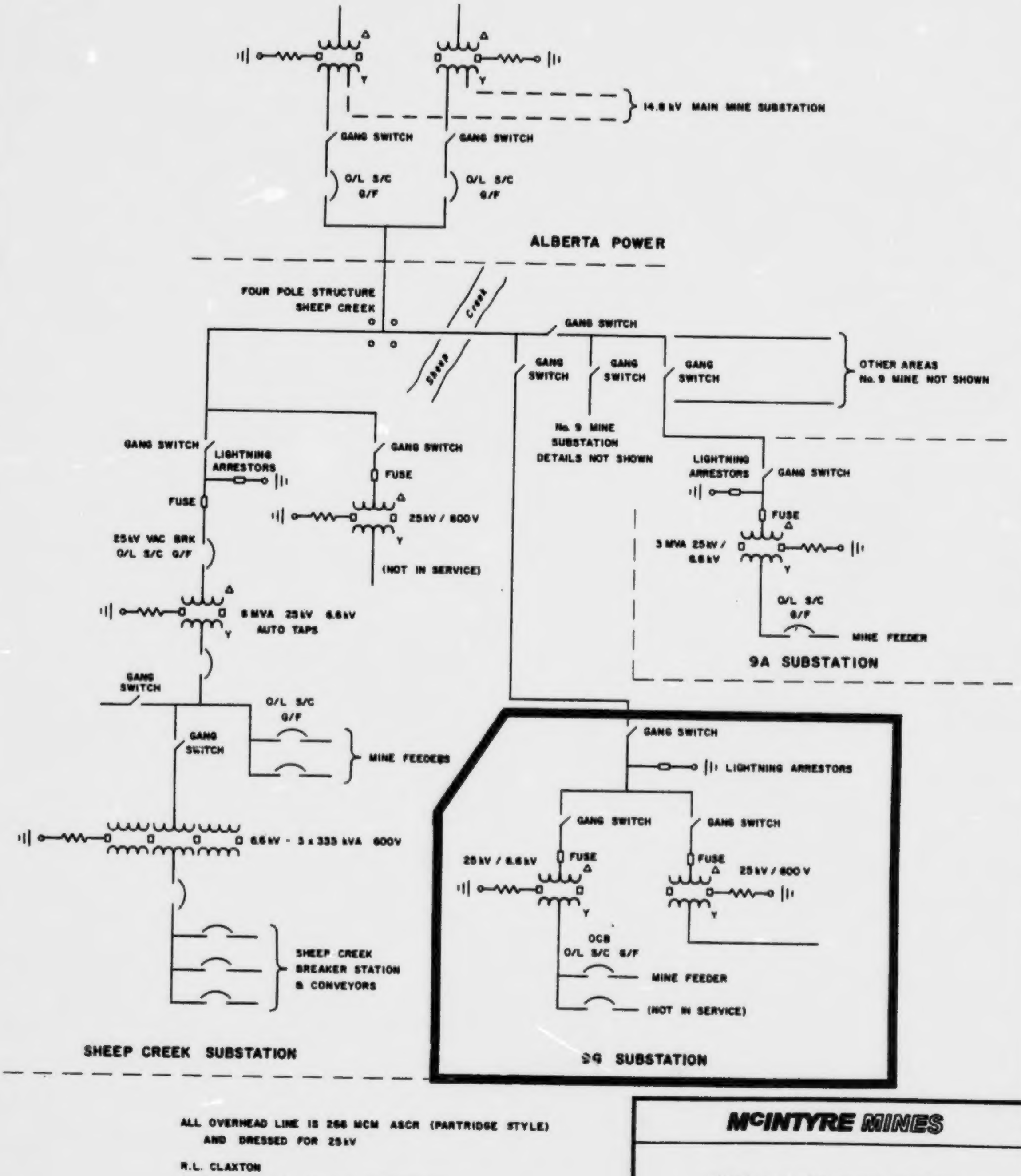

No. 2 Entry
No. 1 Entry
Exhaust Fans
Supplies Entry
Air Heater
Portal Shack
Small Parts Bay
Stacker Conveyor
Three Bay Electrical & Welding Shops
Two Bay Diesel Shop
Switch House
Transformer Pad
Propane
fence
Water Softner
Garbage Bin
Timber Post Bays
Wind Break
Fuel Tank Area
Pipe Racks
Material Bays
Coal Stock Area
Material Bays
Offices
Showers
Overhead Power Line
N
0 20 40 60 80 100 120 140 feet
10 20 30 40 metres

McINTYRE MINES

No. 9G-4 MINE
SURFACE FACILITIES PLAN

NOV. 1982

FIG. 2-8


14.8 kV MAIN MINE SUBSTATION
GANG SWITCH
GANG SWITCH
O/L S/C G/F
O/L S/C G/F
ALBERTA POWER
FOUR POLE STRUCTURE SHEEP CREEK
Sheep Creek
GANG SWITCH
GANG SWITCH
GANG SWITCH
GANG SWITCH
OTHER AREAS No. 9 MINE NOT SHOWN
No. 9 MINE SUBSTATION DETAILS NOT SHOWN
GANG SWITCH
LIGHTNING ARRESTORS
FUSE
25kV VAC BRK O/L S/C G/F
6 MVA 25kV 6.6kV AUTO TAPS
GANG SWITCH
FUSE
25kV / 600V
(NOT IN SERVICE)
LIGHTNING ARRESTORS
GANG SWITCH
FUSE
3 MVA 25kV / 6.6kV
O/L S/C G/F
MINE FEEDER
9A SUBSTATION
GANG SWITCH
O/L S/C G/F
GANG SWITCH
MINE FEEDERS
6.6kV - 3 x 333 kVA 600V
SHEEP CREEK BREAKER STATION & CONVEYORS
SHEEP CREEK SUBSTATION
GANG SWITCH
LIGHTNING ARRESTORS
GANG SWITCH
GANG SWITCH
25kV / 6.6kV
FUSE
FUSE
25kV / 600 V
OCB O/L S/C G/F
MINE FEEDER
(NOT IN SERVICE)
9G SUBSTATION
Δ
Y

ALL OVERHEAD LINE IS 266 MCM ASCR (PARTRIDGE STYLE)
AND DRESSED FOR 25kV

R.L. CLAXTON
16 SEPT. 1982 N.B. NOT FOR CONSTRUCTION

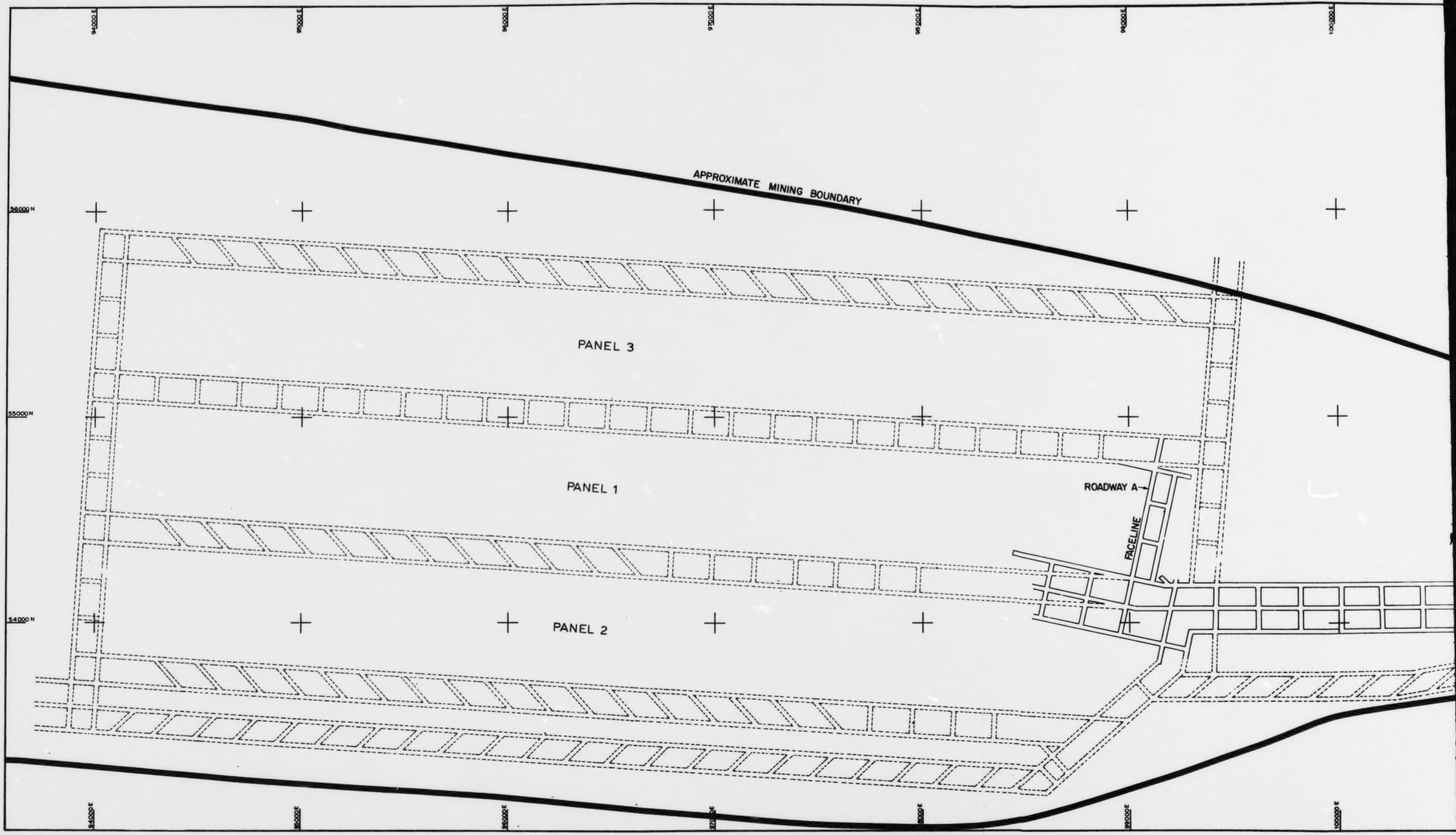
McINTYRE MINES

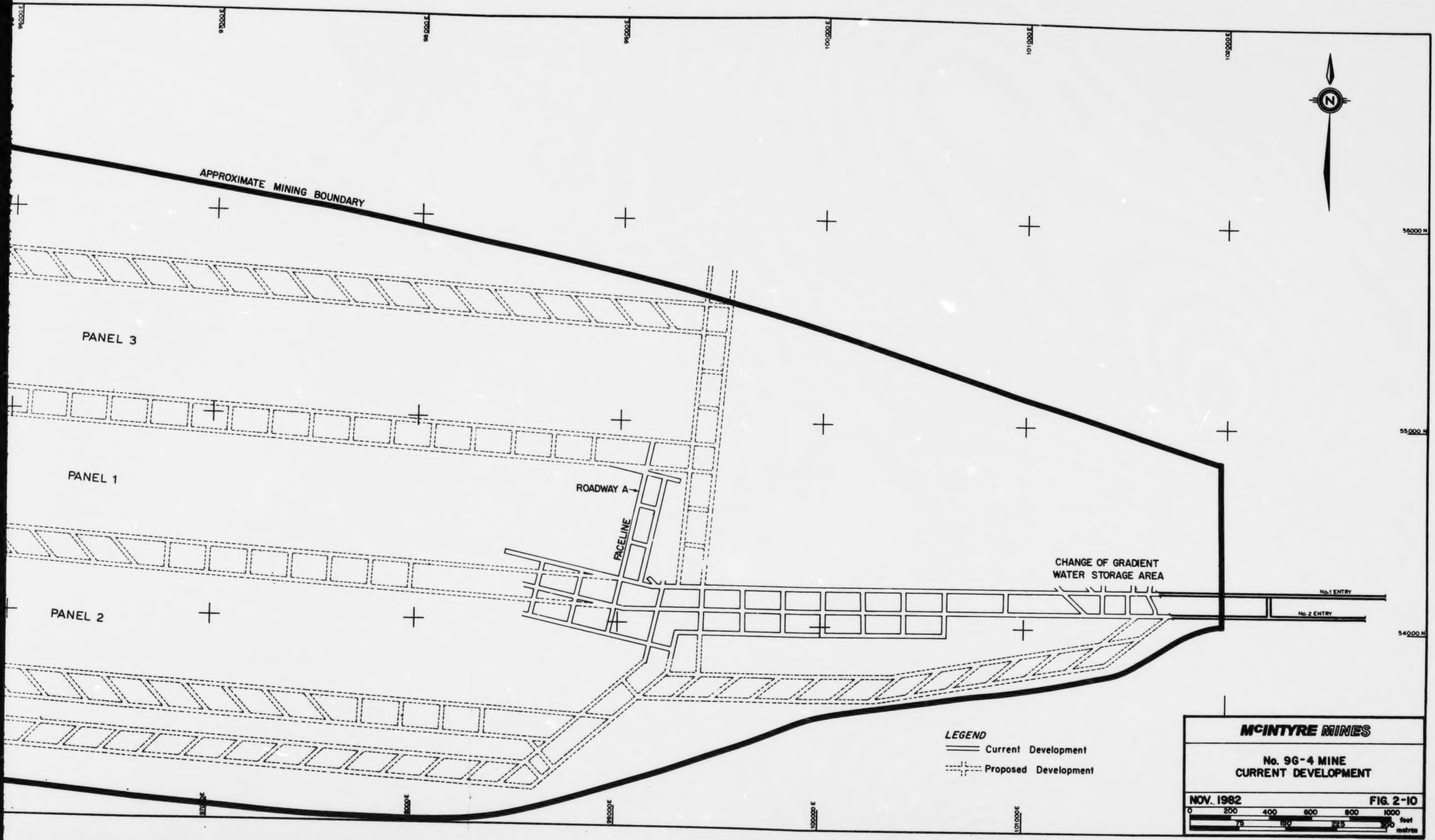
SINGLE LINE 25kV SYSTEM

NOV. 1982

FIG. 2-9

Scale: N.T.S.


94000 E
95000 E
96000 E
97000 E
98000 E
99000 E
100000 E
APPROXIMATE MINING BOUNDARY
56000 N
PANEL 3
55000 N
PANEL 1
ROADWAY A
FACELINE
54000 N
PANEL 2
94000 E
95000 E
96000 E
97000 E
98000 E
99000 E
100000 E


96000 E
97000 E
98000 E
99000 E
100000 E
101000 E
102000 E
N
56000 N
55000 N
54000 N
APPROXIMATE MINING BOUNDARY
PANEL 3
PANEL 1
PANEL 2
ROADWAY A
FACELINE
CHANGE OF GRADIENT
WATER STORAGE AREA
No.1 ENTRY
No.2 ENTRY
LEGEND
Current Development
Proposed Development
0
200
400
600
800
1000
feet
75
150
225
300
metres

McINTYRE MINES

No. 9G-4 MINE
CURRENT DEVELOPMENT

NOV., 1982

FIG. 2-10

3.0 DESIGN CONSIDERATIONS

PLANNING FOR LONGWALL

The planning of an underground mining operation is a complex process involving detailed consideration of many inter-related variables. Consequently, it is often necessary to arrive at a compromise solution based upon an iterative process in which previous experience of mining activity plays a vital role.

Before arriving at a layout and extraction sequence for any longwall mine, the considerations described below must be addressed.

Only reserves defined as proven should be considered for exploitation.

Mine layout and extraction sequences must maximize reserve recovery and productivity, maintain continuity of output and minimize the effects of extraction on any adjacent mineable coal seams.

The longwall mining configuration selected can significantly affect development and roadway maintenance requirements, the level of risk, anticipated production levels and cash flow for the project life. The configuration providing minimum risk and costs should be adopted.

Development systems must be such that sufficient development work can be completed to allow the operation of the initial face and thereafter maintain a development rate sufficient to ensure that replacement faces are available as required. The system should be capable of producing coal at an economic rate. Development roadways should be of an appropriate cross-section to allow for good standards of ventilation with due regard to men and material transport. In-seam development is desirable in order to reduce to a minimum the amount of roof and floor which must be worked.

Ventilation systems should be flexible and able to accommodate changes in ventilation requirements that may occur both seasonally and during the life of the mine. All working places must be provided with sufficient clean air to reduce any concentrations of noxious or flammable gasses and airborne dust to acceptable standards.

Transportation systems must provide for men, material and coal transportation. Rapid safe transportation of the workforce to and from the working place can make a significant contribution to overall productivity by reducing travelling time and increasing available working time. Every effort should be made to provide systems with a minimum number of workers deployed on transportation activities.

Power supply systems must be of sufficient capacity to allow for ready operation of all equipment. Care must be taken to ensure problems of voltage regulation are minimized. Where necessary, flameproof or intrinsically safe equipment must be employed.

Communication systems must be established to ensure the safety of personnel and as an aid to production. As a minimum the system should allow ready two-way communication between working areas, coal transfer points and mine surface.

Pumping systems should be installed if any ingress of water is expected. The pumping system should be designed to function automatically where practicable. The efficient control of unwanted water must be achieved to assure worker comfort and maintain designed production levels.

Firefighting and dust suppression systems must be installed. Guidelines for the installation and maintenance of fire fighting arrangements are published by the Energy Resources Conservation Board and must be complied with as a minimum requirement (Appendix 2-3).

First Aid facilities must be provided both on the surface and underground. A mine rescue service must be available.

4.0 RESERVES AND DESIGN PARAMETERS

ASSUMPTIONS

The specific design parameters for No. 9G-4 Mine are based on the following assumptions:

- The total area of Seam #4 mineable reserves in the No. 9G Mine would be dedicated to recovery by longwall mining.
- Further development of the No. 9G Mine would not commence until a decision whether or not to proceed with the longwall project is reached.
- If longwall were adopted only development directly related to longwall would be undertaken.
- Sufficient manpower for development and longwall working would be available.
- The cost to access additional reserves would be a charge to the recovery of those reserves.
- Wherever possible, production levels, manpower and detailed costs would be based upon existing operating experience.

GEOLOGY AND RESERVES

A catalogue of geological information was established for Seams #4, #10 and #11 in which seam co-ordinates, roof and floor elevations and seam thicknesses were defined. Where possible, geophysical logs were used to determine roof and floor intercepts. Where available, geophysical directional surveys in conjunction with surface surveys were used to determine the location of each seam intercept.

From this data base plans and sections were developed at a 1:200 scale. The cross-sections were constructed at 250 ft intervals (Appendix

2-9). Generally the structural style of the area is best depicted by the Seam #4 structure contour map (Figure 4-1).

Reserve Calculations

The reserve tonnages were classified to show reserves at 0° to 15°, 15° to 20° and greater than 20°. Table 4-2 provides a summary of the reserves by category.

Based on the evaluations by McIntyre and reviewed by its consultants it is concluded that there are some 15.4 million tons of in-place proven reserves in the area being considered for mining.

GEOTECHNICS

The behaviour of the strata adjacent to a longwall during development, mining and after mining can have a significant effect on the safety and productivity of operations.

For successful longwall mining the roof must cave in a controlled manner into the void created by coal extraction. Roof supports must develop sufficient resistance to induce the immediate roof strata behind the supports to break and fall. After caving the caved material should offer support to the upper strata, which can then move downward as an unbroken beam in the mined-out area behind the longwall.

Strata Control Observations

Room and pillar mining is currently being conducted in No. 9A Mine close to the No. 9G-4 Mine. A depillaring section has been retreating along a 500 ft front, providing a realistic indication of the conditions likely to be encountered in longwall operations in No. 9G-4 Mine (Figure 4-2).

Over three months of operation, daily observations of waste caving, roadway closure, pressure on pillars and stress measurements were made in No. 9A-4 Mine. During this period caving occurred in a controlled and satisfactory manner. The first waste fall was usually 4 to 6 ft behind supports left to induce roof break. This fall of some 8 to 10 ft above the seam was at an angle of about 40° to the vertical, subsequently the roof breaks to a higher level and completely fills the void. The waste caves fairly readily and roof control is good.

The progressive development of breaks and the limited outward movement of the coal in pillars showed that the load was being safely taken by the pillars. Very little measureable roadway closure occurred, even in those areas adjacent to the ribside pillars.

Based upon these observations, the following projections have been made related to roof control with a longwall operating in the No. 9G-4 Mine:

- Caving will relieve forward abutment pressure, and strata problems occasioned by roof break or floor heave are not anticipated.
- The waste will cave in a satisfactory and systematic manner.
- Caving will take place in two phases initially taking place up to 8 to 10 ft above the seam and later caving to higher levels to completely fill the void.
- During initial caving the edge of the immediate caved roof will be at an angle of 30° to 40° to the vertical.

Confirmatory geotechnical data has been derived from studies conducted by:

- Norwest Resource Consultants: An Appraisal of the Roof Strata of the No. 4 Seam in the Area Planned for Longwall Development (Appendix 3-2).
- Coal Mining Research Centre: Preliminary Plate Load Tests at McIntyre Mines (Appendix 4-1 Floor Strength).
- Seegmiller International: Geotechnical Evaluation Logging/Testing/Analysis No. 9G-4 Mine (Appendix 3-3).
- R.M. Hardy Associates: Report on Geotechnical and Hydrological Factors Relative to Proposed No. 9 Mine Extension (Appendix 4-1 Geotechnical Data).

Support Requirements

Based on observations at No. 9A Mine calculation has determined that the minimum support capacity required for No. 9G-4 Mine is 450 tons. In order to provide a safety factor, 600 ton capacity supports will be specified. Figure 4-4 shows a typical arrangement for roof supports. Tests and observations confirm that the immediate roof and floor strata in No. 9G-4 Mine are able to withstand the forces to be applied.

Conclusions

The reserves in the No. 9G-4 Mine are geotechnically amenable to extraction by longwall mining, provided the longwall support system is appropriately engineered.

LONGWALL GEOMETRY

In most cases it is not possible to achieve an optimum value for every variable in longwall operation and a compromise solution must be sought. For example, to achieve total coal recovery the full seam section should be extracted and no coal should be left in pillars. This is not technically feasible in Seam #4 so a compromise must be adopted which will maximize recovery within the limitations of available equipment and mining techniques.

Tests conducted by CMRC to determine the strength of various coal horizons in the seam show that the bearing strength of the soft coal zone near the middle of the seam is very low and that difficulties would be encountered if roof supports were required to operate on a floor of this material. However, the coal sections above and below this zone are capable of supporting the loads that may be imposed by modern roof support systems at yield condition. Figure 4-5 shows the thickness of hard coal above the sheared coal zone for a 10 ft extraction height.

Current longwall technology is successfully being applied in many locations to extract thick seams about 10 to 12 ft in height. Equipment capable of extracting even thicker sections is in limited use. An extraction height of 10 ft would allow well proven mining techniques and equipment to be employed, thus maximizing the potential for success.

The recommended extraction section is 10 ft with the supports based upon a strong coal floor and operating to the roof of the seam.

Face Length

Generally longer faces provide improved productivity since the ratio of face cutting time to operation delay time is improved. Reserve recovery is also improved since the ratio of face extraction volume to support pillar volume increases but constraints on face length are imposed by considerations of capital cost, mechanical capability and operational control.

To ensure total caving of the waste at No. 9G-4 Mine the depth of operation requires that face lengths be in excess of 400 ft (CMRC Study Appendix 3-4). A 550 ft face operating length has been selected in order to:

- Maximize reserve recovery within the mine boundary.
- Ensure that longwall equipment is employed well within its design limits.
- Maintain potential for extraction of Seam #10 with longwall of viable length.

Roadway and Face Alignment

The presence of residual stress and tectonically induced strata fractures can have a significant effect on development and longwall mining activities.

The major fracture patterns associated with previous tectonic activity occur along a northwest-southeast line. Minor breaks occur at right angles to the direction of the major break-lines. The break pattern within the coal and strata may cause problems, unless roadway and face alignment are correctly chosen. To optimize roof control a face alignment which is not parallel to either line of break is recommended.

Panel Alignment

The area of coal to be exploited in No. 9G-4 Mine is roughly rectangular. To maximize reserve recovery the most appropriate direction of development and extraction is either development along-strike with the face-line on dip, or development to-the-dip with the face-line along-strike.

Alignment in either direction would ensure that extraction would be at an angle of some 20° to the tectonically induced line of fracture.

DEVELOPMENT CONFIGURATION

The longwall will extract the top 10 ft of the seam and the development roadways will be driven in this same section.

The floor of the roadways must be relatively horizontal across the roadway and the roof beds above the seam should not be disturbed during development. Equipment and techniques in current use can drive roadways at seam grades of up to 18°.

To minimize ventilation pressure drops roadway cross-sections should be a minimum of about 120 sq ft.

Mining layouts for longwall extraction can be developed using single or multiple entry systems. In general, single entry configurations provide maximum reserve recovery while multiple entry systems reduce recovery unless pillars can be recovered.

Development of No. 9G-4 Mine using a single entry configuration would require roadway drivage techniques not presently employed at Smoky River.

There has been extensive experience in developing long drivages using the two and three-entry systems, with coal pillars between roadways for support at Smoky River. The advantage of using two-entry roadways developed by existing equipment include:

- Reduced capital expenditure.
- Reasonable rates of advance and productivity.
- Availability of trained and experienced supervisory and operating personnel.
- Ease of supply and equipment installation both during development and for longwall operations.
- Use of proven ventilation systems for the development activity.
- Provision of a second means of egress for mine operatives employed on the development activity.

Recommended System

To maximize reserves recovery the minimum number of development roadways, ideally one, should be driven. However, to utilize a single-entry drivage system a technique new to Western Canada would need to be employed and a number of mining problems would require resolution.

Such problems would be avoided with a two entry configuration, since the equipment and operating expertise are readily available. The two entry system is therefore recommended.

MINING CONFIGURATION

Longwall mining equipment can be deployed and operated in any of three different configurations:

- Advancing
- Retreating
- Advance/retreat

All three configurations are successfully employed elsewhere and any one could be applied at Smoky River. The adoption of a particular configuration determines the mine layout and development/roadway maintenance requirements. Selection of the most appropriate configuration can simplify operations and provide the best environmental conditions.

Advancing

In longwall advance the equipment is installed and advances into the reserve area with the gate and supply roadways being developed as the face advances (Figure 4-7). Single roadways supported on steel arches are generally used. Since the roadways developed with the face are the only means of access they must be supported at the caved edge by packs or chocks to assist in maintaining the roadway. This can restrict the rate of face advance.

Retreating

In longwall retreat the equipment is installed between pre-driven roadways which extend for the total length of the panel to be extracted (Figure 4-8). Faces are retreated from the end of the developed roadways which are allowed to collapse following coal extraction. Support density in these roadways is usually less than for single-entry systems. Since the area to be mined has been circumscribed by developed roadways a sound knowledge of the geology and mining conditions is available before mining.

Advance/Retreat

In longwall advance/retreat the equipment is installed between two pre-driven roadways which extend for some distance ahead of the face-line and continue to be developed as the face advances (Figure 4-9). Limited information on geology and mining conditions ahead of the face is available from development but the operation is complex and requires co-ordination of all activities to ensure proper operation.

Table 4-3 summarizes the advantages and disadvantages of each configuration as they apply to the No. 9G-4 Mine.

Recommended Configuration

The outcome of the demonstration longwall project will have a significant impact on the propagation of longwall mining in Western Canada and the method selected should offer the minimum risk. Although it requires significant pre-production expenditure on development drivages, longwall retreat using twin entries is recommended as the lowest risk approach.

SUMMARY

The following parameters have been derived and adopted for the detailed design of the longwall:

- Some 15.4 million tons of in-place reserves in Seam #4 will be exploited.
- A retreating longwall configuration will be used.
- A two-entry development method will be employed using existing equipment.
- A total caving system will be adopted using 600 ton supports.
- A 10 ft section will be extracted with the supports based on a competent coal floor, contacting the roof of the seam.
- The face length will be approximately 550 ft.
- The alignment of development roadways and longwall faces will be at approximatly 20° to the direction of tectonically induced fractures.

TABLE 4-2

PROVEN RESERVES - 9G-4 MINE

# 4 SEAM

	RESERVES IN PLACE (LTR)
0 - 15°	6,271,000
15 - 20°	7,310,000
+ 20°	1,823,000
TOTAL	15,404,000

TABLE 4-3
COMPARISON OF LONGWALL MINING CONFIGURATIONS

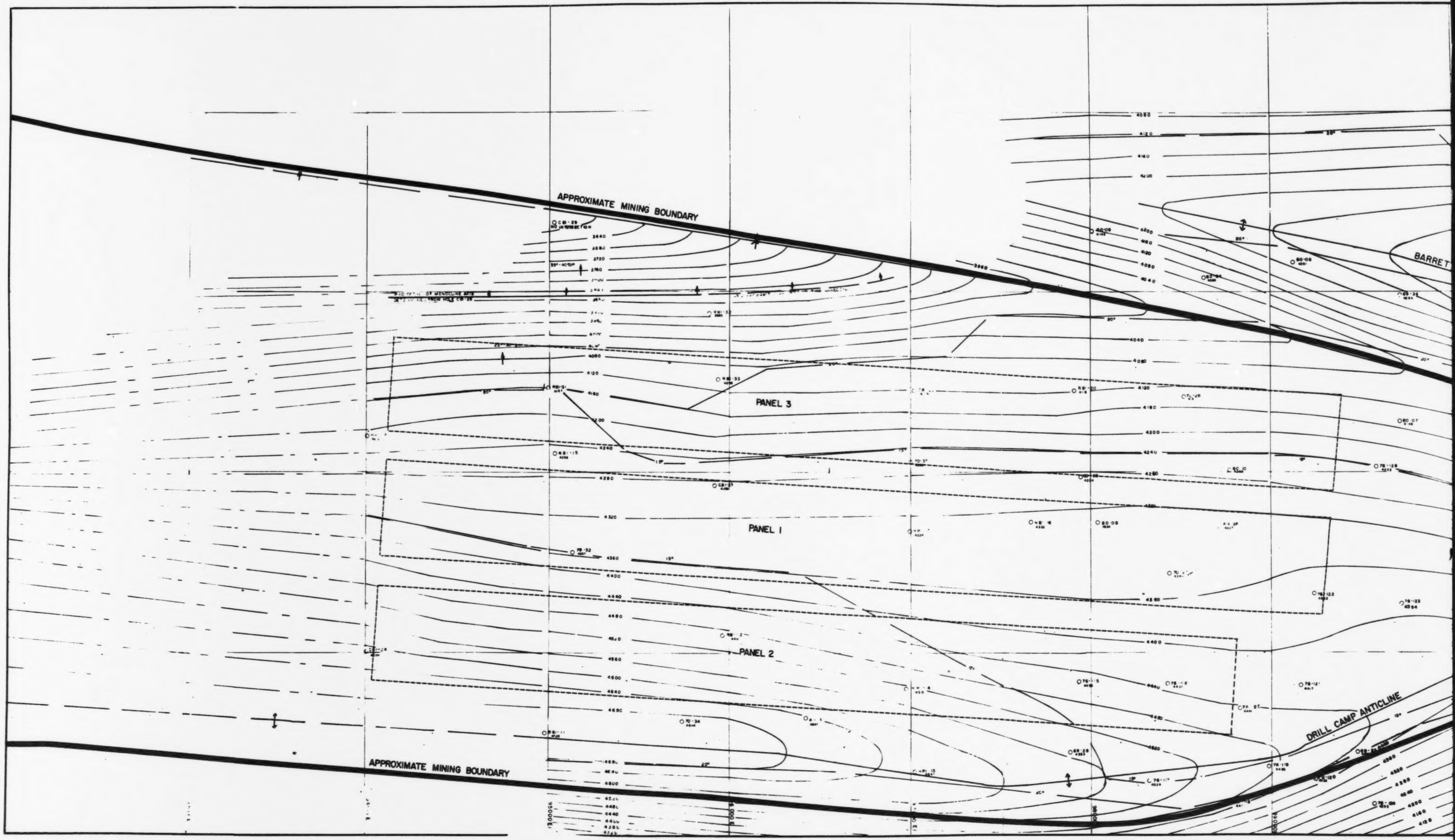
ITEM	ADVANCE LONGWALL	RETREAT LONGWALL	HYBRID LONGWALL RETREAT
1. Mining Related Data	Restricted to borehole data and data obtained from adjacent mining activities.	Maximum amount of data available.	As for advance system, supplemented by limited additional data from advanced roadway development.
2. Roadway Development	Roadways are developed with the face advance. Single steel supported entries are normal.	Roadways are fully developed before face installation. Single or multi entry systems may be used.	Roadways are developed ahead of the face. Single or multi entry systems may be used.
3. Roadway Maintenance	Heavy roadway maintenance requirement usual where thick seams are extracted.	Limited roadway maintenance required. Attention to front abutment zone may be required.	Heavy maintenance requirement for single entry system. Attention to abutment zone may be required for multi entry system.
4. Roadside Packs	Required to provide roadway stability.	Not normally required.	Required if single entry system adopted.
5. Reserve Recovery	Maximized with this system, particularly if roadways can be reused.	Development configuration affects recovery.	Development configuration affects recovery.
6. Face Extraction - Panel Length	Can exceed prescribed length if mining conditions are favourable.	Prescribed.	Can exceed prescribed length if mining conditions are favourable.
7. Mining Support Equipment Conveyors, Pipelines, etc.	Installed as face advances.	Fully installed at commencement of face operations. Withdrawn as face retreats.	Installed as face advances.

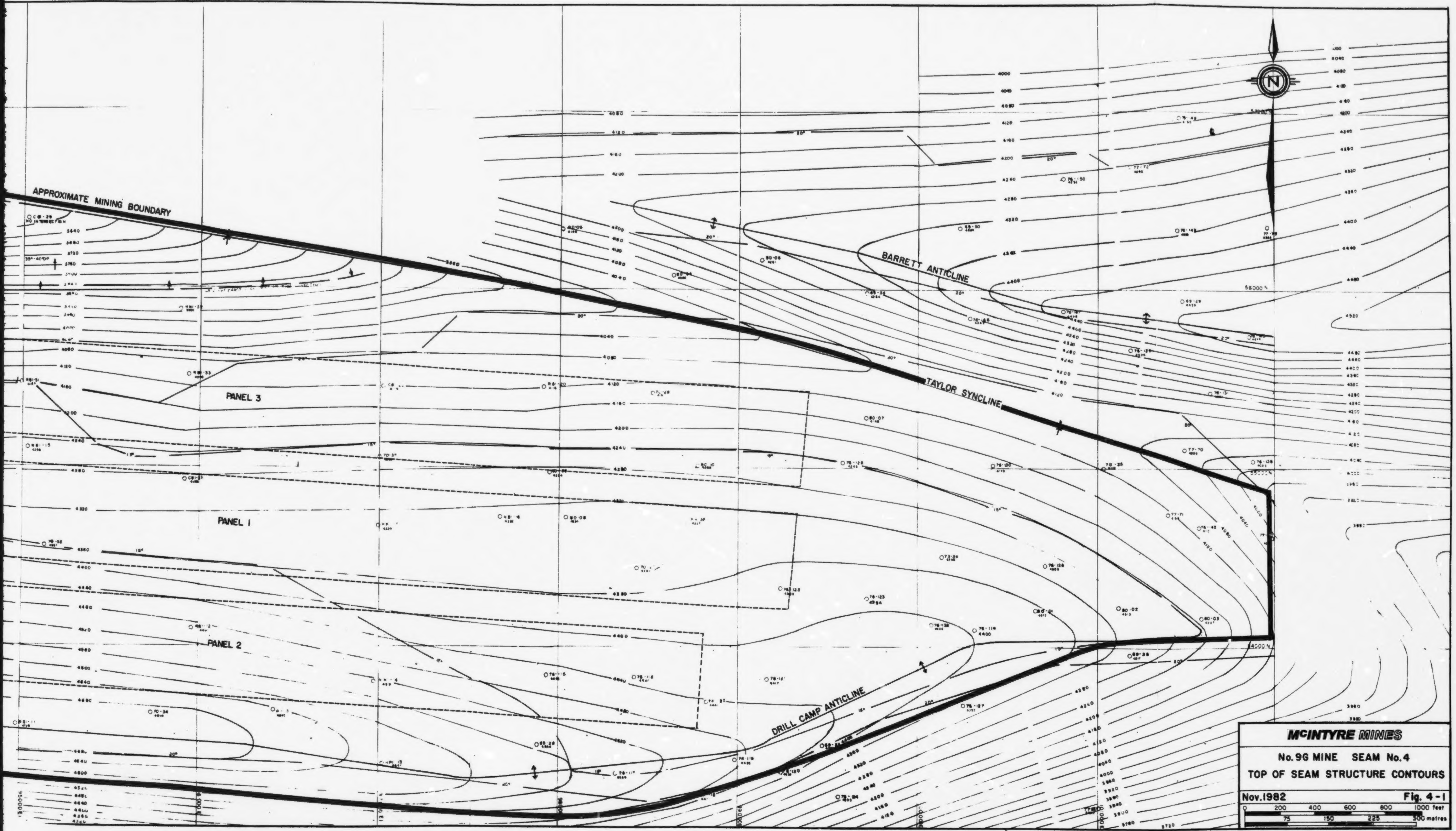
TABLE 4- (Cont'd)
COMPARISON OF LONGWALL MINING CONFIGURATIONS

ITEM	ADVANCE LONGWALL	RETREAT LONGWALL	HYBRID LONGWALL RETREAT
8. Development Equipment	Usually specialized or heavily manpower intensive.	No special requirements unless single entry systems envisaged.	No special requirements unless single entry systems are envisaged.
9. Ventilation System	Relatively simple, must accommodate ventilation for headings.	Simple and uncomplicated.	Complex arrangements necessary to ensure proper ventilation of advance headings.
10. Spontaneous Combustion	Can be the source of continuing problems.	Can be more readily controlled - problems left behind as face retreats.	This system is not suitable if spontaneous combustion problems are to be anticipated.
11. Mining System	Special roadhead arrangement necessary to accommodate roadway drivage. Packs required along roadside.	Simple.	Complex activity on both development and longwall must be coordinated. Single entry systems require roadway packs following face extraction.
12. Environmental Control	Difficult at face ends.	Relatively simple.	Difficult at face ends due to advance drivage activity.
13. Equipment Recovery	May be difficult, all face and other equipment must be transported out along roadways which may have converged.	Equipment is recovered as face retreats.	As for advance - additional large items of equipment require transportation.

TABLE (Cont'd)
COMPARISON OF LONGWALL MINING CONFIGURATIONS

ITEM	ADVANCE LONGWALL	RETREAT LONGWALL	HYBRID LONGWALL RETREAT
14. Face and Development Supplies	Must be transported and stored until used in single roadway subject to convergence. Distance increases as face advances.	Relatively simple since transport will be through unstressed roadways and distance decreases as face retreats.	Similar to advance but additional difficulties may arise in transporting materials across the face line.
15. Initial Face Installation	Presents a short route for transport and installation.	May require lengthy transportation and require longer installation time.	Same as for advance.
16. Expenditure Required Before Face Installation	Reduces initial development expenditure to a minimum.	Requires maximum expenditure on development.	Require more than minimum expenditure as initial development expenditure determined by amount of roadway maintained ahead of face advance.
17. Manpower at Face	Development work crew must be included. Construction of roadway packs requires additional manpower and equipment.	Face operations crew only.	Significant number of additional persons employed on development work. Single entry system will require roadway pack erection crew.
18. Mining Risk	Highest, since only minimum of information on expected mining conditions available.	Lowest since maximum amount of mining data available.	High since only limited data data available at outset of mining.


APPROXIMATE MINING BOUNDARY
CB-29 NO INTERSECTION
3640
3680
3720
3760
PROJECTION OF MONOCLINE AXIS
4000
4080
4120
4160
4200
4240
4280
4320
4360
4400
4440
4480
4520
4560
4600
4640
4680
PANEL 3
PANEL 1
PANEL 2
BARRETT
DRILL CAMP ANTICLINE
APPROXIMATE MINING BOUNDARY

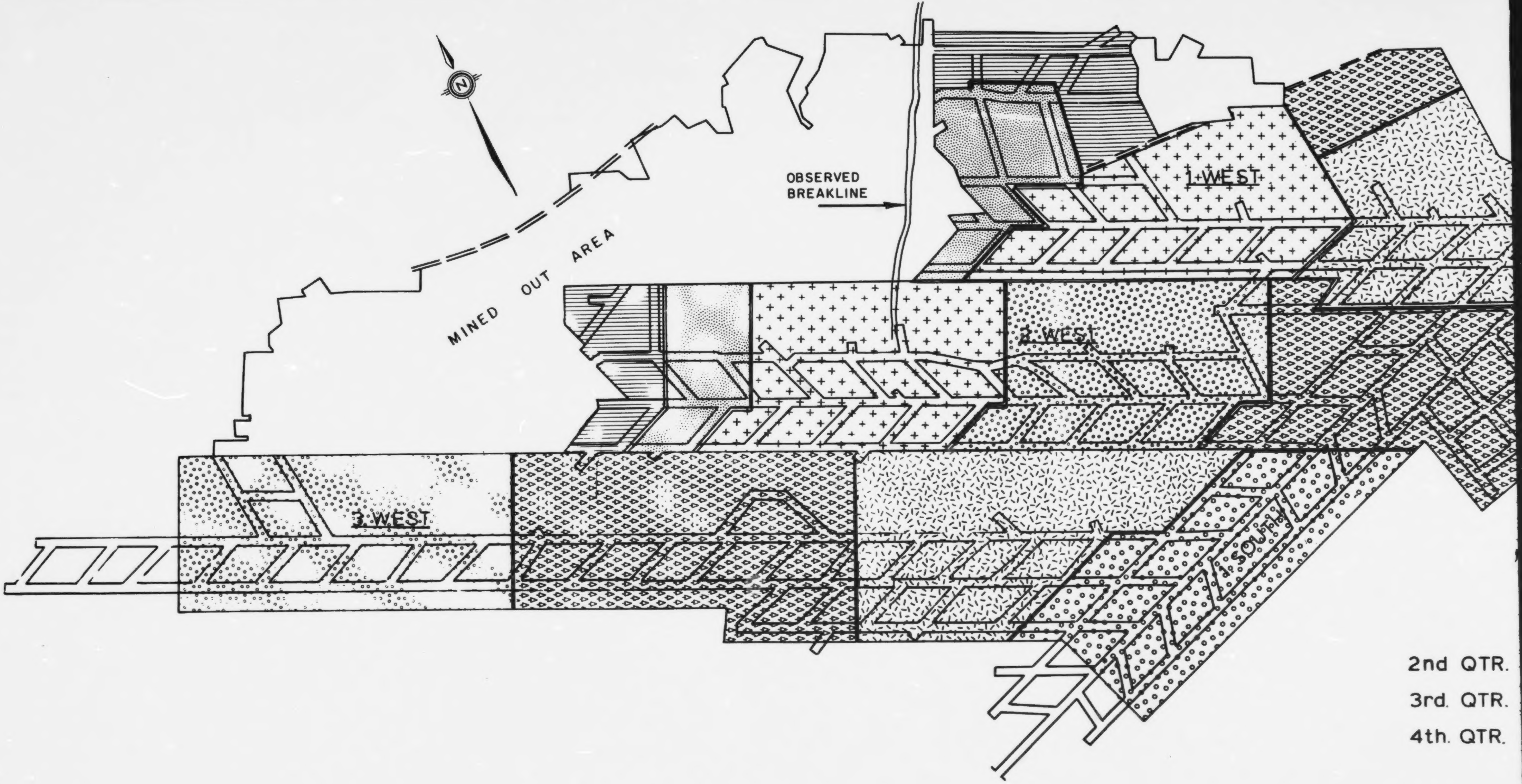

APPROXIMATE MINING BOUNDARY
BARRETT ANTICLINE
TAYLOR SYNCLINE
DRILL CAMP ANTICLINE
PANEL 3
PANEL 1
PANEL 2
N
58000 N
56000 N
54000 N
4000
4040
4080
4120
4160
4200
4240
4280
4320
4360
4400
4440
4480
20°
15°
0 200 400 600 800 1000 feet
75 150 225 300 metres

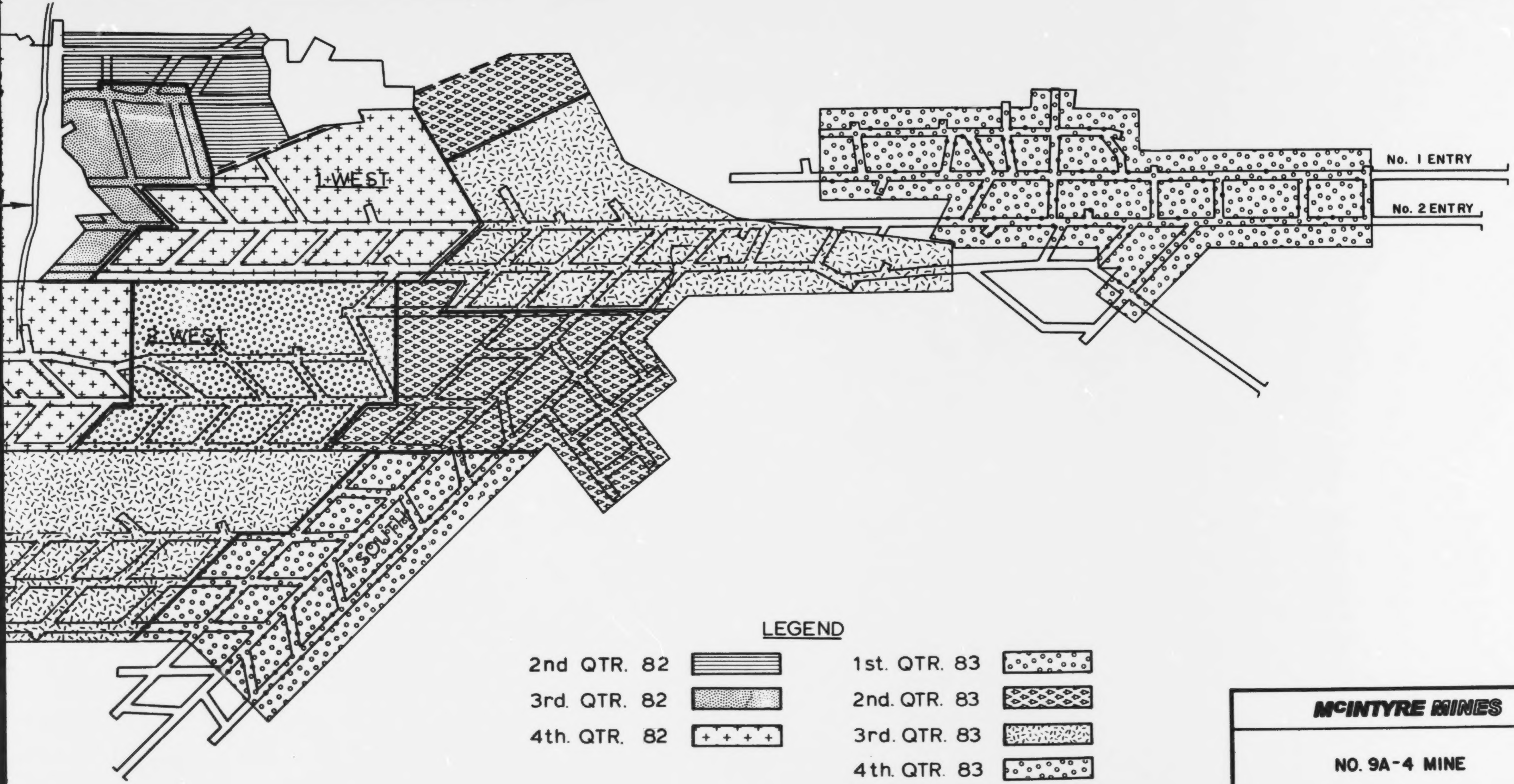
McINTYRE MINES

No. 9G MINE SEAM No. 4
TOP OF SEAM STRUCTURE CONTOURS

Nov. 1982

Fig. 4 - 1


N
OBSERVED
BREAKLINE
MINED OUT AREA
1 WEST
2 WEST
3 WEST
SOUTH
2nd QTR.
3rd. QTR.
4th. QTR.


No. 1 ENTRY
No. 2 ENTRY
1 WEST
2 WEST
1 SOUTH
LEGEND
2nd QTR. 82
3rd. QTR. 82
4th. QTR. 82
1st. QTR. 83
2nd. QTR. 83
3rd. QTR. 83
4th. QTR. 83

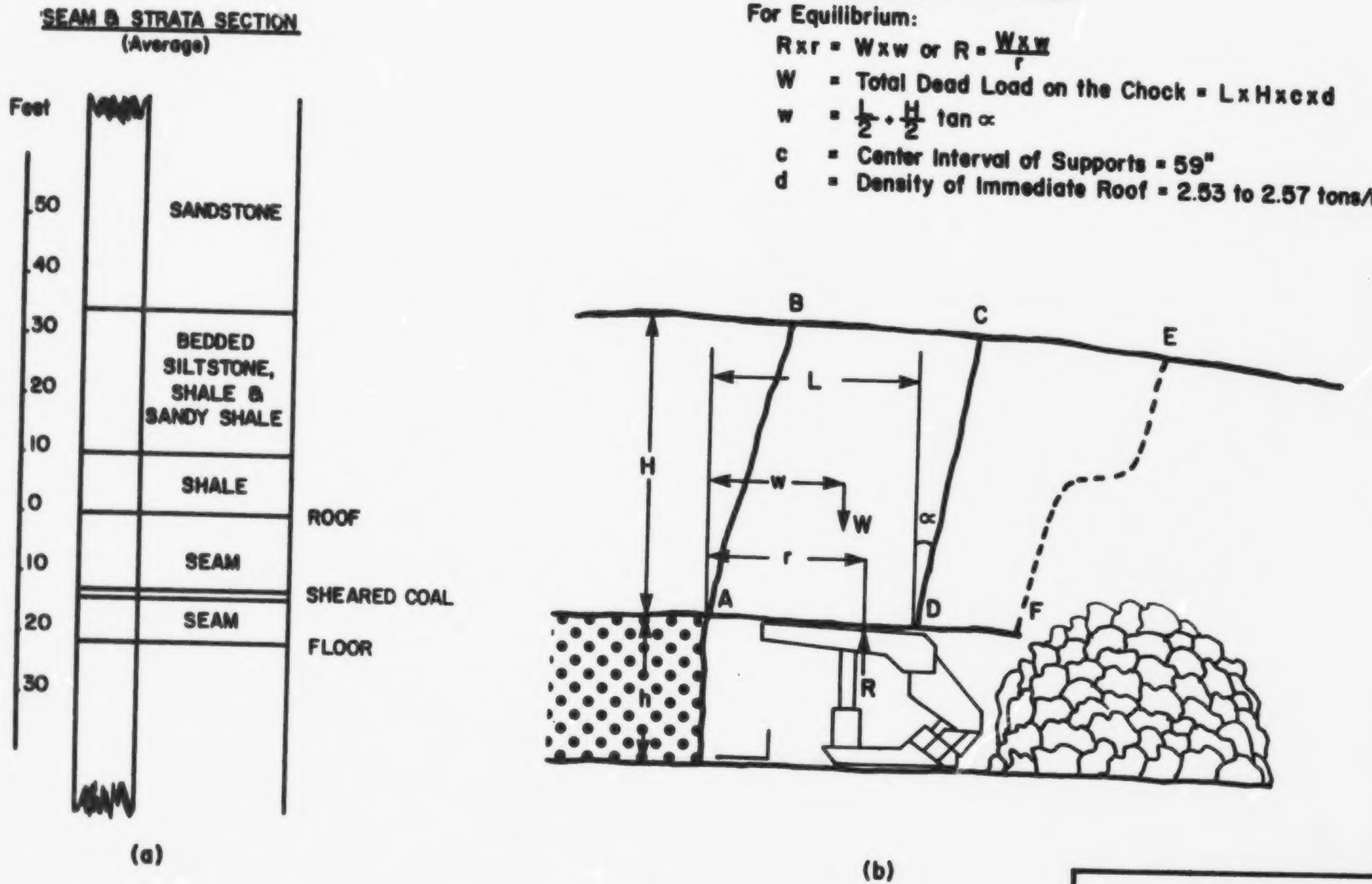
McINTYRE MINES

NO. 9A-4 MINE

NOV. 1982

FIG. 4-2

Scale: N.T.S.


SEAM & STRATA SECTION
(Average)
Feet
50
40
30
20
10
0
10
20
30
SANDSTONE
BEDDED SILTSTONE, SHALE & SANDY SHALE
SHALE
SEAM
SEAM
ROOF
SHEARED COAL
FLOOR
(a)
B
C
E
L
H
w
W
α
r
A
D
F
R
h
(b)

STRATA SUPPORT CONTROL

For Equilibrium:

$R \times r = W \times w$ or $R = \frac{W \times w}{r}$

W = Total Dead Load on the Chock = $L \times H \times c \times d$

w = $\frac{L}{2} + \frac{H}{2} \tan \alpha$

c = Center Interval of Supports = 59"

d = Density of Immediate Roof = 2.53 to 2.57 tons/meter^3

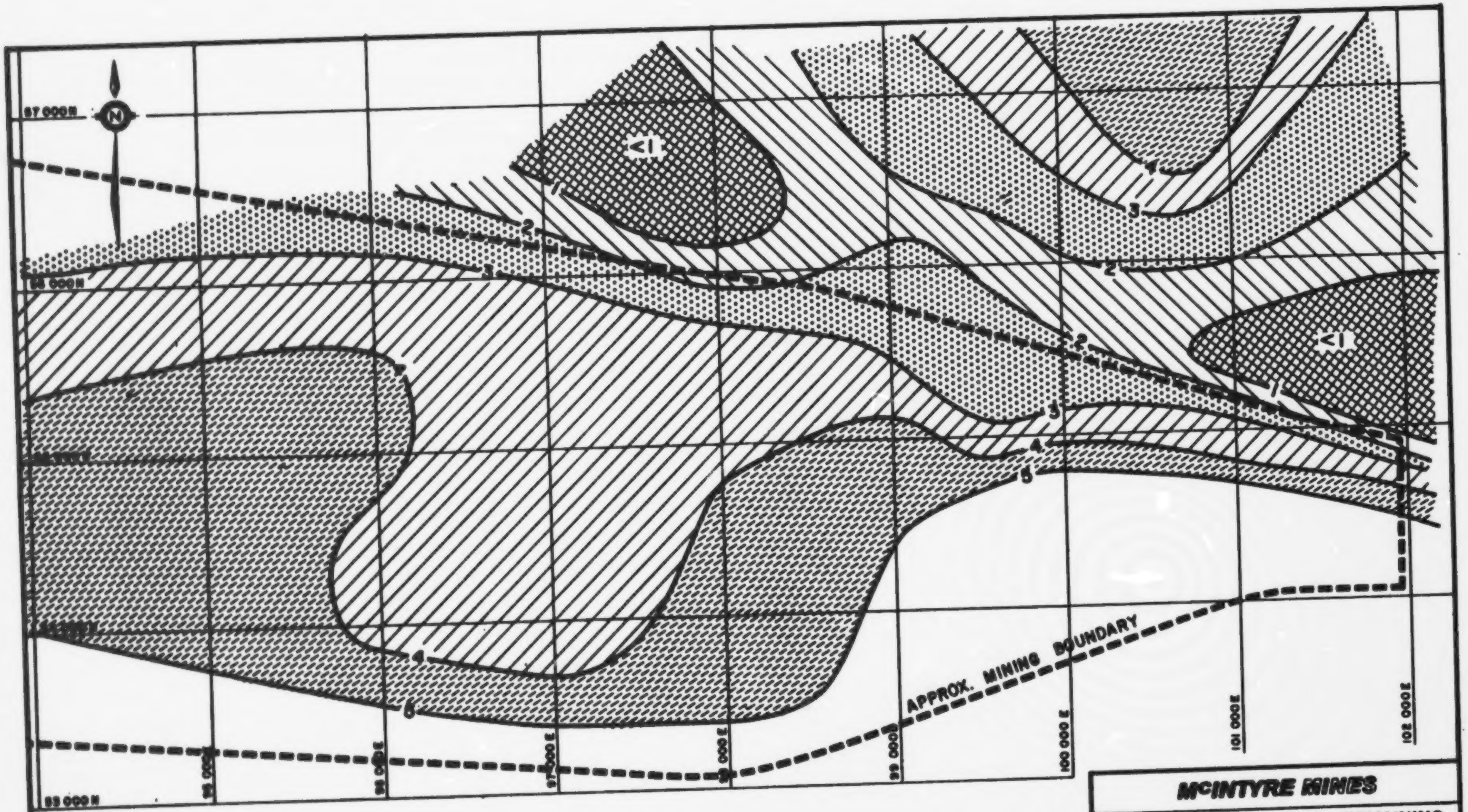
McINTYRE MINES

TYPICAL ARRANGEMENT
FOR ROOF SUPPORT

NOV. 1982

FIG. 4-4

Scale: N.T.S.


N
97 000 N
96 000 N
93 000 N
95 000 E
96 000 E
97 000 E
98 000 E
99 000 E
100 000 E
101 000 E
102 000 E
<1
<1
1
2
2
2
3
3
3
4
4
4
5
5
APPROX. MINING BOUNDARY
100 0 100 200 300 400 500 metres
0 500 1000 1500 feet

LEGEND

- ▨ – BETWEEN 4 + 5 FEET IN THICKNESS
- ▨ – BETWEEN 3 + 4 FEET IN THICKNESS
- ▨ – BETWEEN 2 + 3 FEET IN THICKNESS
- ▨ – BETWEEN 1 + 2 FEET IN THICKNESS
- ▨ – LESS THAN 1 FOOT IN THICKNESS

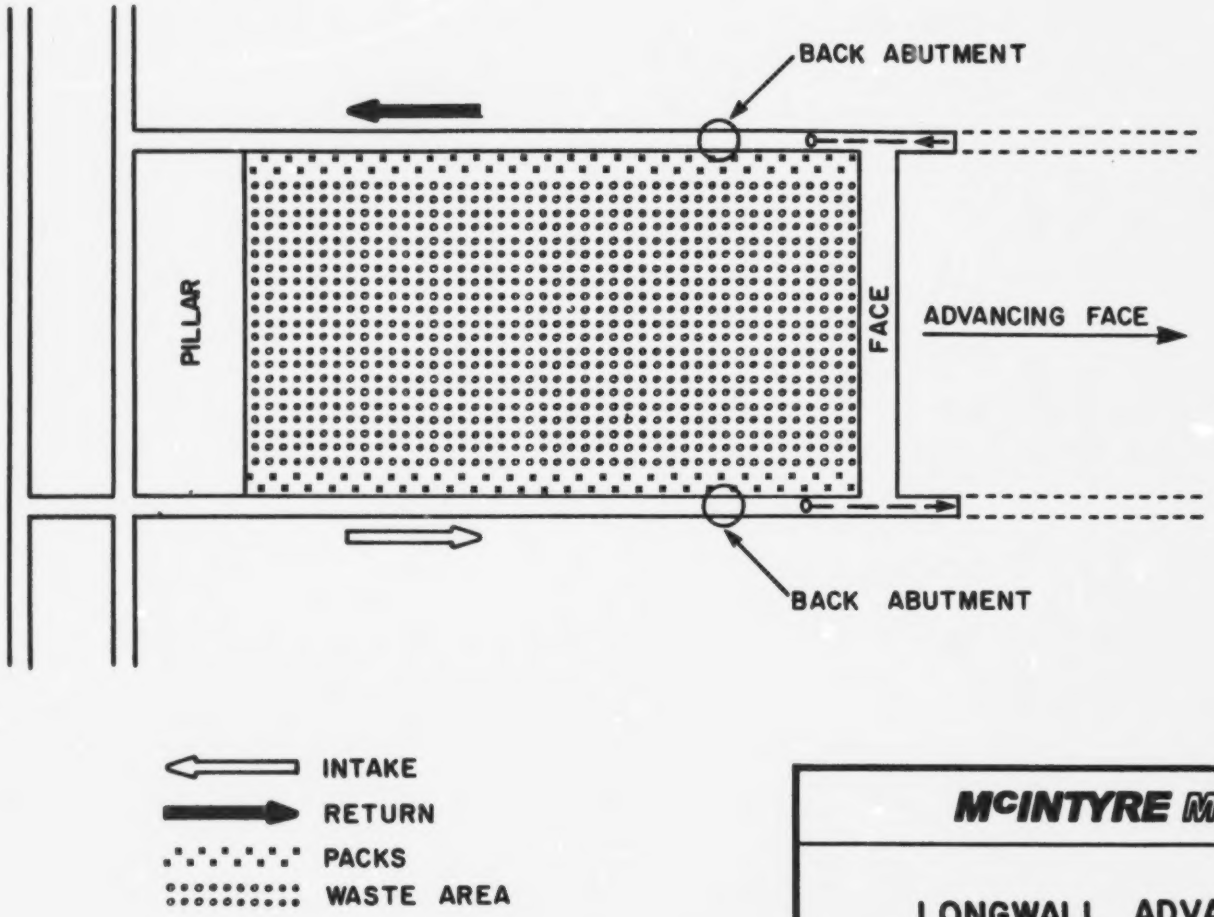
NOTE: CONTOURS DERIVED FROM NorWest MAP 5

McINTYRE MINES

ISOPACH OF HARD COAL REMAINING FOLLOWING EXTRACTION OF TOP 10 FEET

NOV. 1982

FIG. 4-5

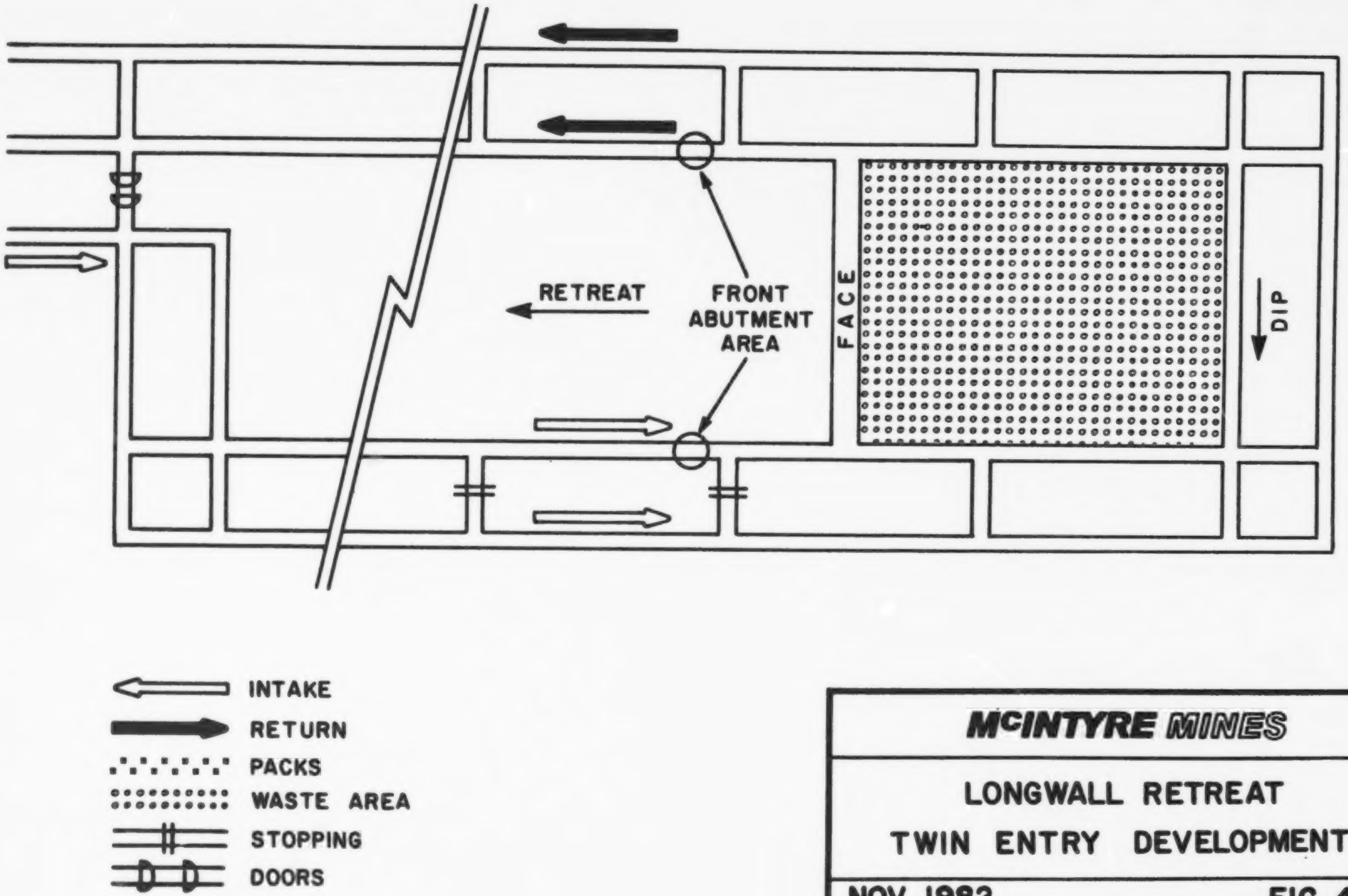

BACK ABUTMENT
PILLAR
FACE
ADVANCING FACE
BACK ABUTMENT
INTAKE
RETURN
PACKS
WASTE AREA

McINTYRE MINES

LONGWALL ADVANCING

NOV. 1982 FIG. 4-7

Scale: N.T.S.

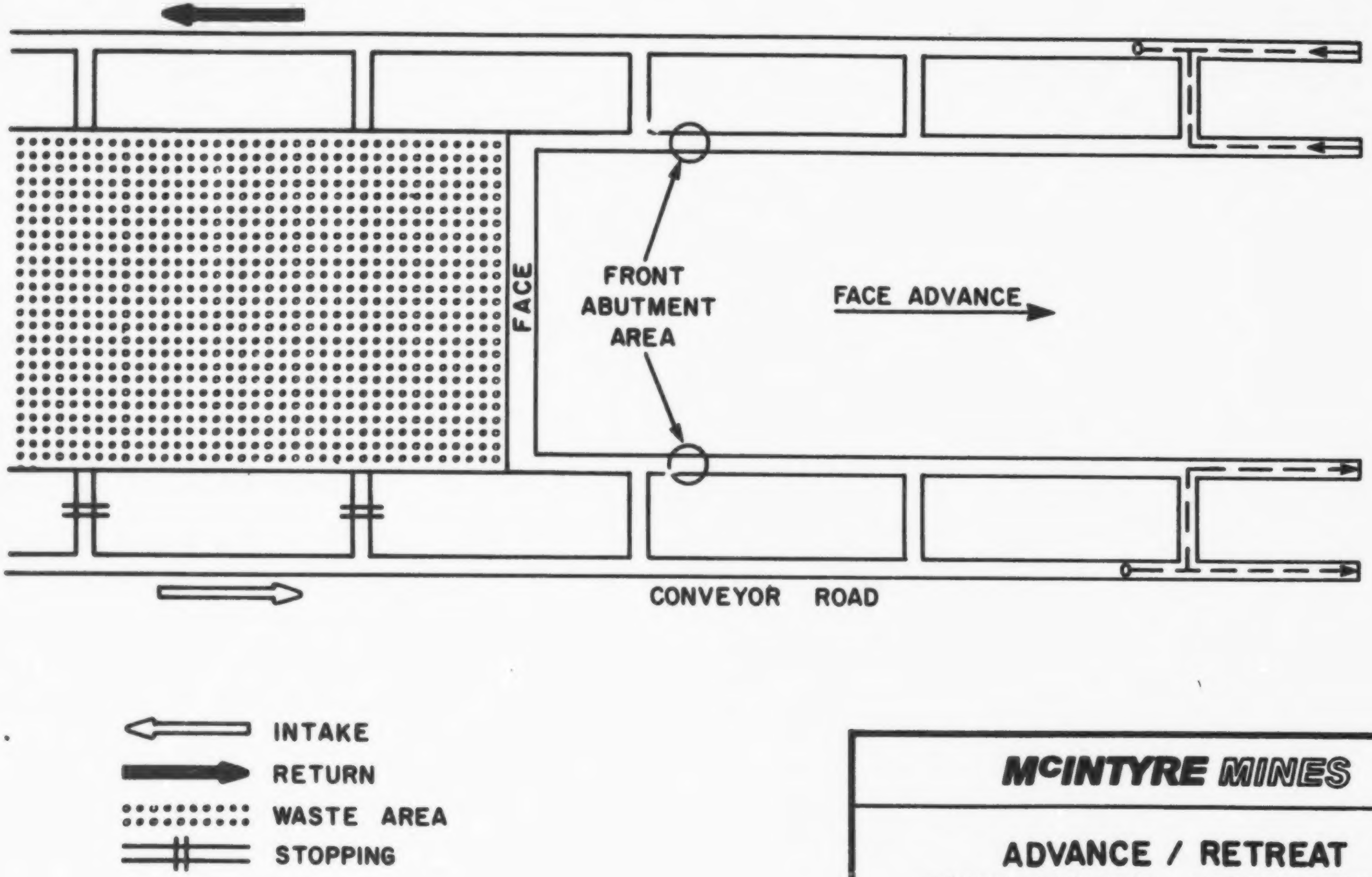

RETREAT
FRONT ABUTMENT AREA
FACE
DIP
INTAKE
RETURN
PACKS
WASTE AREA
STOPPING
DOORS

McINTYRE MINES

LONGWALL RETREAT
TWIN ENTRY DEVELOPMENT

NOV. 1982 FIG. 4-8

Scale: N.T.S.


FACE
FRONT ABUTMENT AREA
FACE ADVANCE
CONVEYOR ROAD
INTAKE
RETURN
WASTE AREA
STOPPING

McINTYRE MINES

ADVANCE / RETREAT
TWIN ENTRY DEVELOPMENT

NOV. 1982

FIG. 4-9

Scale: N.T.S.

5.0 LONGWALL DESIGN FOR NO. 9G-4 MINE

ACCESS

Services

Any longwall layout would require similar services in terms of transport and ventilation. At present the mine geometry imposes some limitations on the ability to transport large pieces of equipment and provide adequate ventilation for a longwall operation.

To effect the required improvement in transportation and ventilation systems two roadways will be driven to intersect the No. 2 Access Entry (Figure 5-2).

Pillar Size

Calculations indicate that the appropriate pillar size for the duty is 120 ft by 300 ft (Appendix 3-4). These dimensions have been adopted.

In addition to appropriate pillar sizing, additional roadway support will be provided as required in the abutment pressure areas during mining operations.

PANEL LAYOUT

Various layouts for retreat mining systems were evaluated in terms of development entry systems and direction of working. Only retreat systems were considered since advancing systems would be at high risk.

The layout with development roadways driven along-strike and the longwalls operating on-dip has been selected as the most appropriate (Figure 5-7) for the following reasons:

- The first face can be developed with existing equipment and operational within some 9 months.
- The life of each panel will be about 12 months, with fewer transfers of equipment than other layouts producing the maximum tonnage between equipment transfers.
- The mining configuration with faces on-dip, retreating along-strike is well established.
- Ventilation arrangements are simple.
- Face equipment is installed at the furthest point of development in good conditions and retreats outbye making equipment recovery relatively simple.
- Water will flow away from the face-line to the lower roadway allowing easier control.
- Existing free-steered diesel powered vehicle transportation systems can be used.
- Entries to districts are direct, reducing ventilation resistance and allowing long conveyor runs.
- Replacement faces readily completed in ample time.

Typical Face Specification

- Development system	2-entry
- Face length	550 ft
- Extracted height	10 ft
- Pillar width	120 ft
- Direction of mining	Retreat/faces on-dip
- Panel Run	4800 ft

SUBSIDENCE AND SEAM INTERACTION

Surface movement resulting from subsidence can have an impact on surface structures and sub-surface movement of the strata may affect the potential for recovery of coal seams located above the seam being mined. Longwall mining with fully caved waste areas usually produces the most uniform and manageable subsidence pattern.

Effect on Seam #10 of Mining Seam #4

The degree of disturbance in any particular area is normally related to the width of the working and height above the extracted area. In certain circumstances the total subsidence experienced may reach as much as 0.9 times the extracted thickness. The subsidence profile for Seam #10 which is located some 200 ft above Seam #4 has been derived and is shown in Figure 5-10.

An examination of this subsidence profile indicates that if longwall mining were adopted face lengths of 350 to 400 ft could be worked in the de-stressed fully subsided areas of Seam #10.

Surface Effects of Mining Seam #4

The surface will be subjected to subsidence over an area greater than that worked underground. Stress will be developed as the workings move across the area and a break may occur.

The potential effect on the surface has been calculated and is shown in Figure 5-11. This shows that the final profile may be lowered by some 9 ft over the mined areas.

In the area to be worked surface subsidence is a minor consideration. There are no surface structures of importance and no special arrangements will be necessary.

HAULAGE AND TRANSPORT

Recommended System

It is proposed to continue the use of conveyors for coal transportation and diesel powered free-steered vehicles for supplies since there are no significant advantages to be gained from any other systems. Where steep grades (+15°) are likely to be encountered such as 2 North Development, modified techniques will be adopted at the appropriate time. To ensure that good roadway conditions can be maintained a diesel powered roadway grader specifically designed for use in underground mines will be employed.

Vehicles designed for the transport of large items of equipment and for the transportation of men will be employed where appropriate.

VENTILATION

Statutes require that sufficient air must be available at all parts of the mine to dilute and render harmless all noxious and flammable gasses. The ventilation system must also ensure that acceptable environmental conditions are maintained, particularly the levels of respirable dust.

At all mines previously and currently operated at Smoky River the exhaust ventilation system has been satisfactorily applied and will be continued. Methane concentrations of less than 0.2% in the general air body when ventilated with approximately 20 000 cfm are typical.

Longwall Face Ventilation

The longwall face is designed to produce coal at over 4000 tons per day. This may liberate considerable quantities of methane during mining operations and since the waste will be fully caved behind the face methane may also migrate to the face-line from the adjacent Seams #10 and #11.

Since it is difficult to assess the magnitude of potential migration, it is important to ensure that an adequate quantity of air is available. The ventilation system has been designed to provide 60 000 cfm for ventilation of the longwall. Experience at other mining operations indicates that it is unlikely that this quantity will be required and normally 30 000 to 40 000 cfm will prove adequate.

Figure 5-18 shows the ventilation system for extraction of the first panel and development of the second.

Spontaneous Combustion

While many opportunities for spontaneous combustion have been present, no occurrence of spontaneous combustion has ever been noted in previous mining activity in Seam #4 at Smoky River. Provided reasonable standards of mining practice are followed the risk of such an occurrence is considered to be negligible.

Main Ventilation

The maximum requirement for ventilation air will occur when a longwall face and one development unit are operating. To provide adequate ventilation for those two activities requires approximately 100 000 cfm at the operating locations comprised of 60 000 cfm for the longwall operation and 40 000 cfm for development (Figure 5-20). To provide the required volumes of air two additional roadways (No. 3 and 4) will be driven (Figure 5-2).

In order to achieve the required ventilation levels at a volumetric efficiency of 50% fan capacity of approximately 200 000 cfm will be installed at the mine surface.

FIRE FIGHTING AND DUST SUPPRESSION

The water supply system will accommodate the demands of both firefighting and dust suppression.

A water storage and pumping facility suitably protected against the extremes of temperature likely to be encountered will be provided to accommodate the fluctuating demand for dust suppression water and minimum standby capacity for firefighting.

The total daily water requirement of approximately 78 000 gallons can be readily supplied from the 93 600 gallons available.

POWER SUPPLY SYSTEM

The main power supply to the mine is provided by a 25 kV overhead line system originating at the Milner Plant substation.

At the surface of No. 9G-4 Mine a transformer with a maximum capacity of 5 MVA is installed which transforms the voltage from 25 to 6.6 kV for distribution in the underground mine. In addition, a 1 MVA transformer transforms the voltage from 25 kV to 550 volts for general surface distribution and utilization.

Longwall equipment would be supplied at 1100 volts. Flameproof and intrinsically safe equipment would be used exclusively below ground.

DRAINAGE AND WATER CONTROL

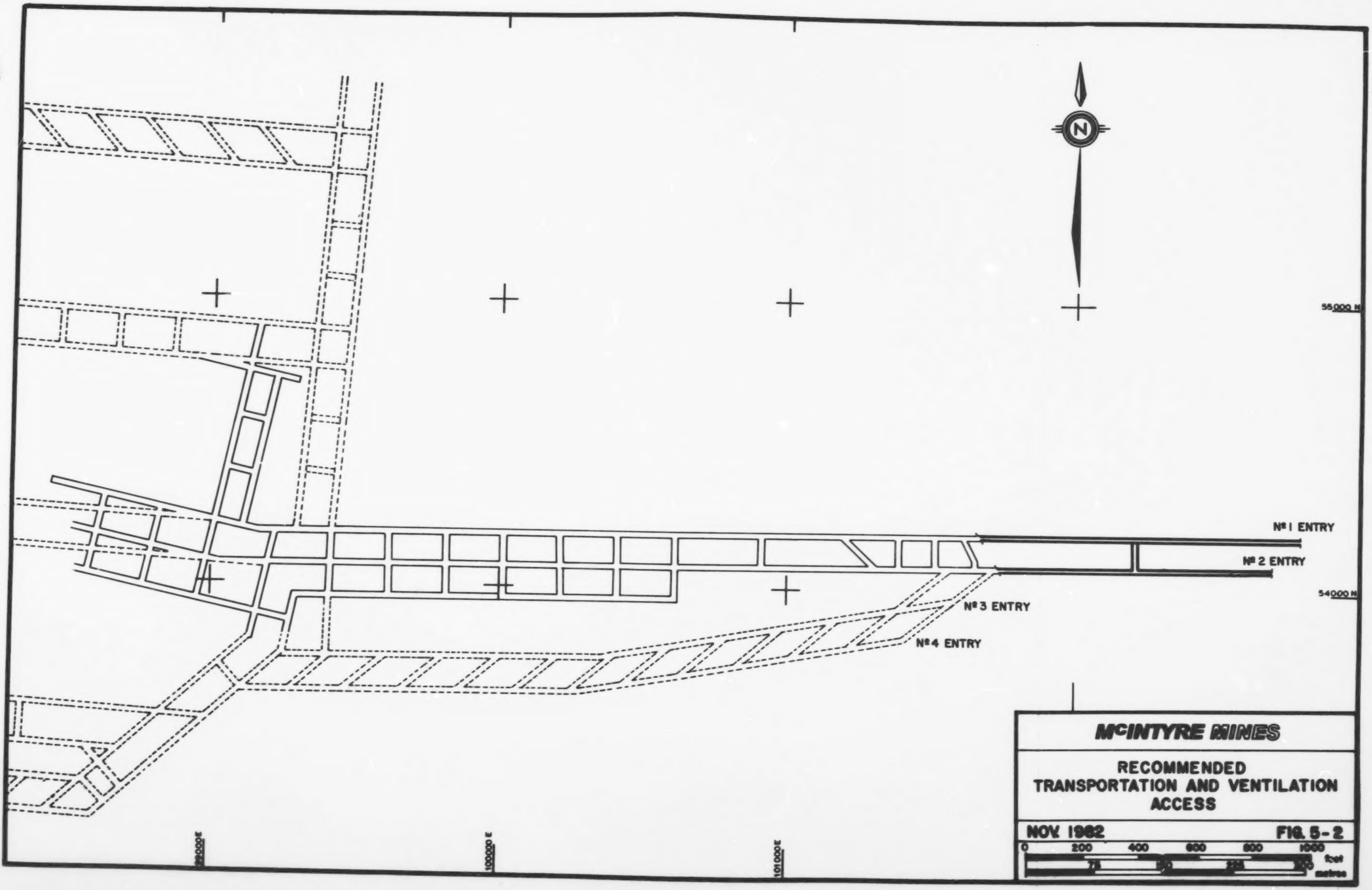
To minimize adverse effects from ingress of water into the working areas a water control scheme will be implemented during development and longwall operations.

Operating Experience

Room and pillar mining operations in both No. 9A-4 and No. 9G-4 Mines have been subject to minor difficulties caused by the ingress of water into the working area which exacerbates the floor conditions resulting in vehicle traction problems. Water ingress has usually been confined to a zone within 300 ft of the heading faces. As the developments advance the water dries out in the roadways behind the drivages. Quantities of up to 50 gpm have been encountered.

Control

Based on experience at No. 9A-4 and No. 9G-4 Mines a pumping scheme capable of handling up to 150 gpm (50 gpm per heading) will be required for development (Figure 5-24). Longwall operations may result in an increase in water quantity but this is not considered likely since a large volume of the water contained in any aquifers will already have been drained during the development activity.

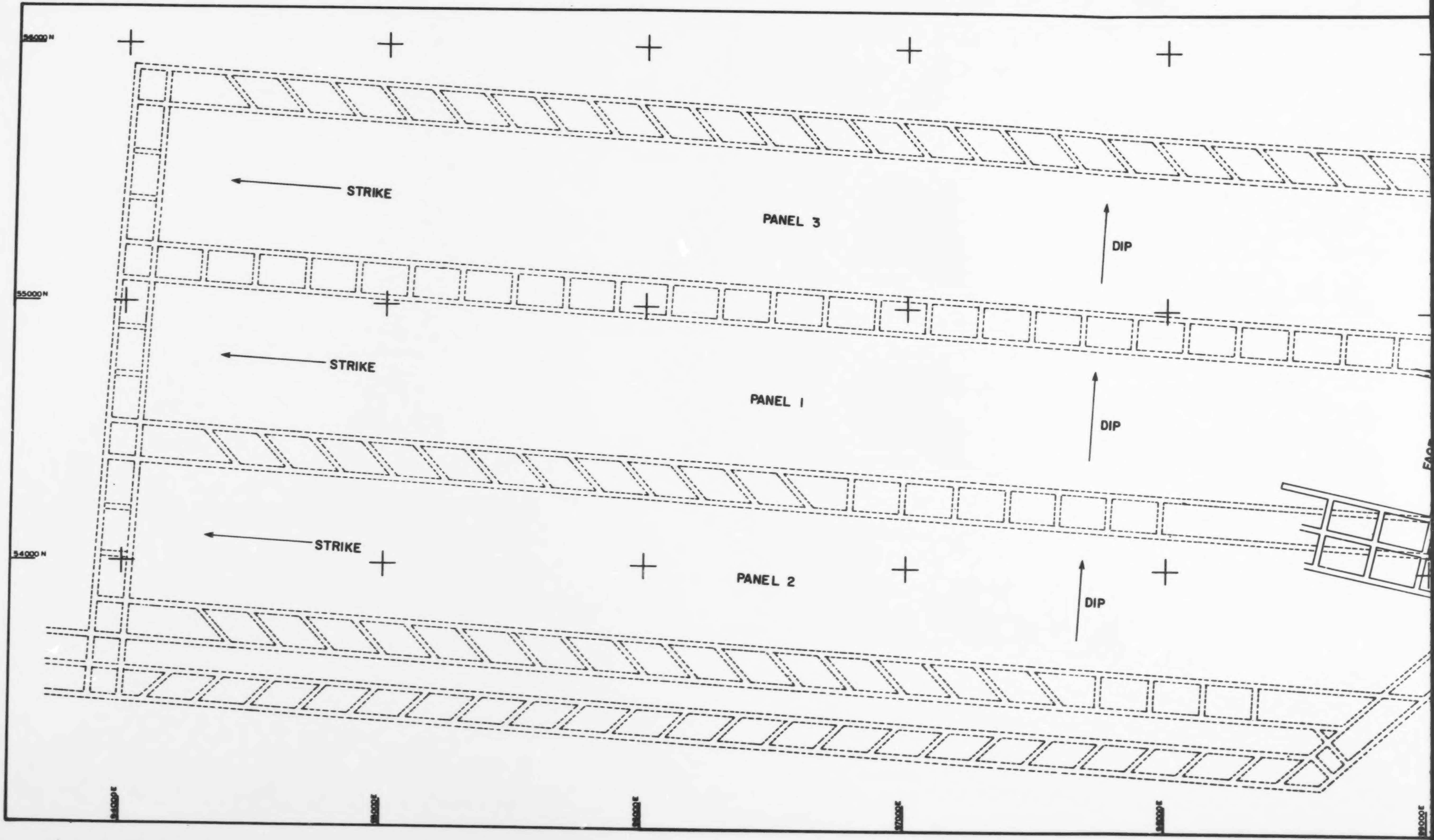

N
55000 N
54000 N
Nº 1 ENTRY
Nº 2 ENTRY
Nº 3 ENTRY
Nº 4 ENTRY
99000E
100000 E
101000E
0
200
400
600
800
1000
feet
75
150
225
300
metres

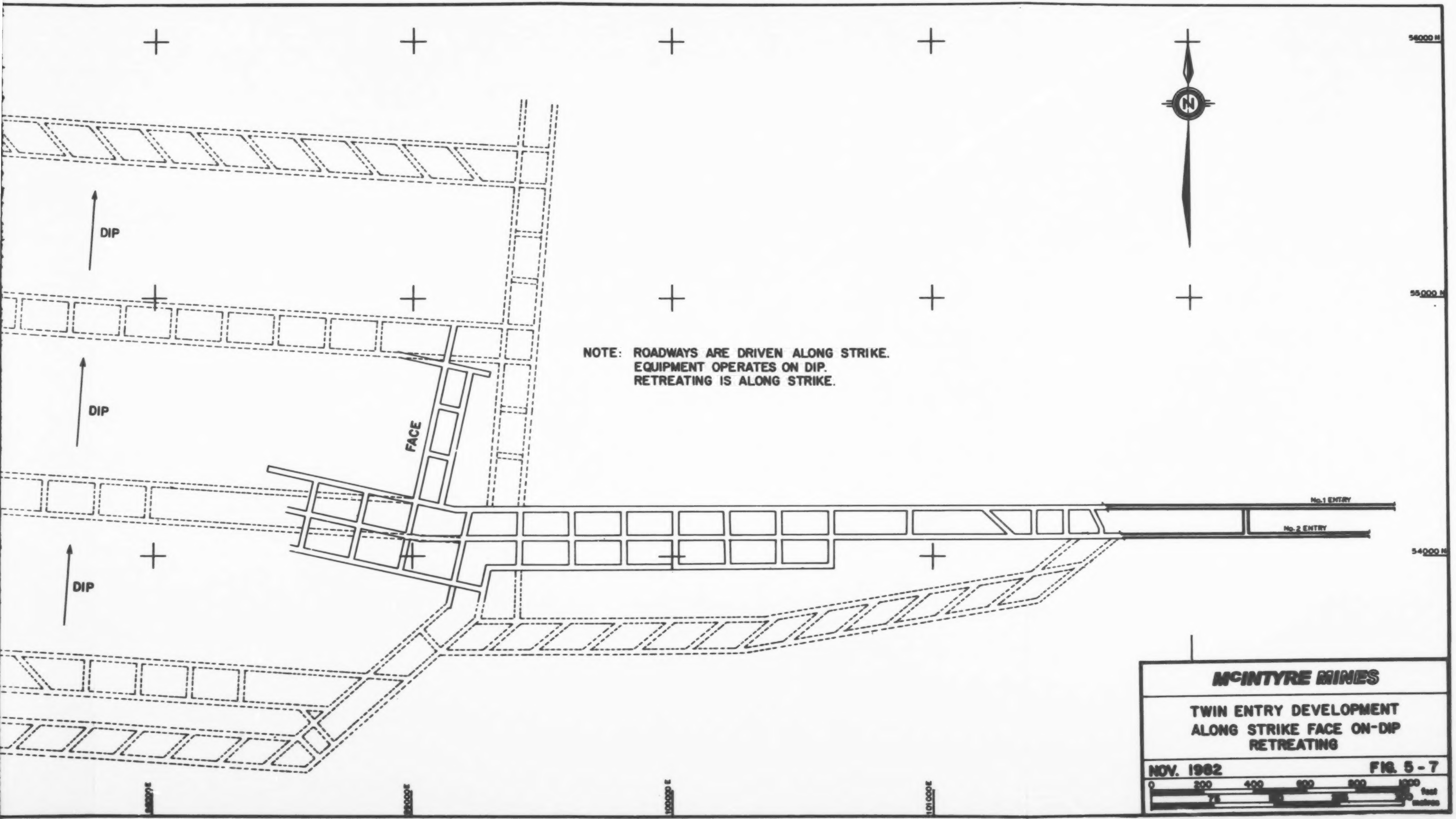
McINTYRE MINES

RECOMMENDED
TRANSPORTATION AND VENTILATION
ACCESS

NOV. 1982

FIG. 5-2


56000 N
55000 N
54000 N
STRIKE
PANEL 3
DIP
STRIKE
PANEL 1
DIP
STRIKE
PANEL 2
DIP
34000E
35000E
36000E
37000E
38000E
39000E


56000 N
55000 N
54000 N
98000E
99000E
100000E
101000E
DIP
DIP
DIP
FACE
No.1 ENTRY
No.2 ENTRY
N
0
200
400
600
800
1000
feet
metres

NOTE: ROADWAYS ARE DRIVEN ALONG STRIKE.
EQUIPMENT OPERATES ON DIP.
RETREATING IS ALONG STRIKE.

McINTYRE MINES

TWIN ENTRY DEVELOPMENT
ALONG STRIKE FACE ON-DIP
RETREATING

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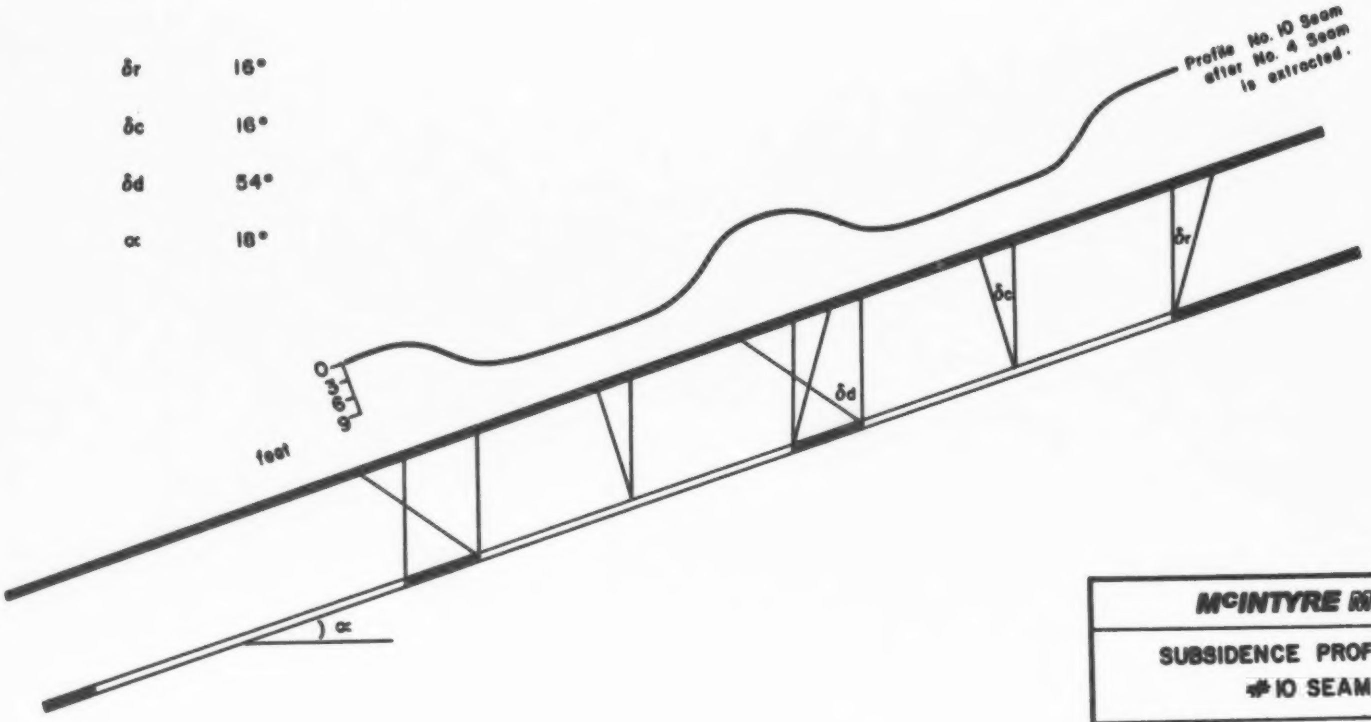
FIG. 5 - 7

SUBSIDENCE SEAM TO SEAM (basis Subsidence Engineers Handbook 1975 N.C.B.)

Face Width	550 feet	w	w/h	= 550 + 200 = 2.75
Seam Extraction	10 feet	m	S max.	= 0.9 x 10 = 9 feet
Interval	200 feet	h		

δr	16°
δc	16°
δd	54°
α	18°


Profile No. 10 Seam after No. 4 Seam is extracted.
0
3
6
9
feet
δr
δc
δd
α

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SUBSIDENCE PROFILE FOR
#10 SEAM

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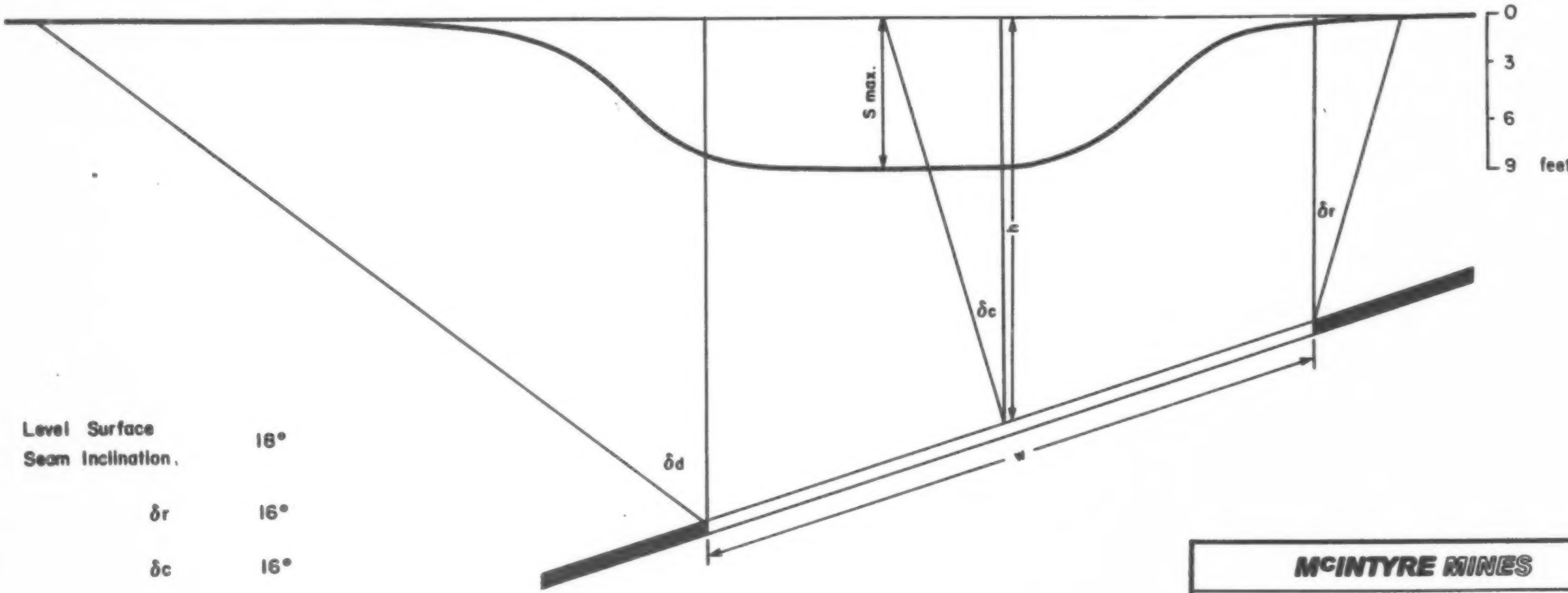
FIG. 5-10

Scale: N.T.S.

POTENTIAL SURFACE EFFECT AT 1,200' AVERAGE DEPTH

Extracted Width	550 feet	w
Seam Extraction	10 feet	m
Depth of Cover	1200 feet	h

w/h = 550 ÷ 1200 = 0.40
S max. = 0.9 x m = 9 feet
S max. maximum subsidence
S subsidence



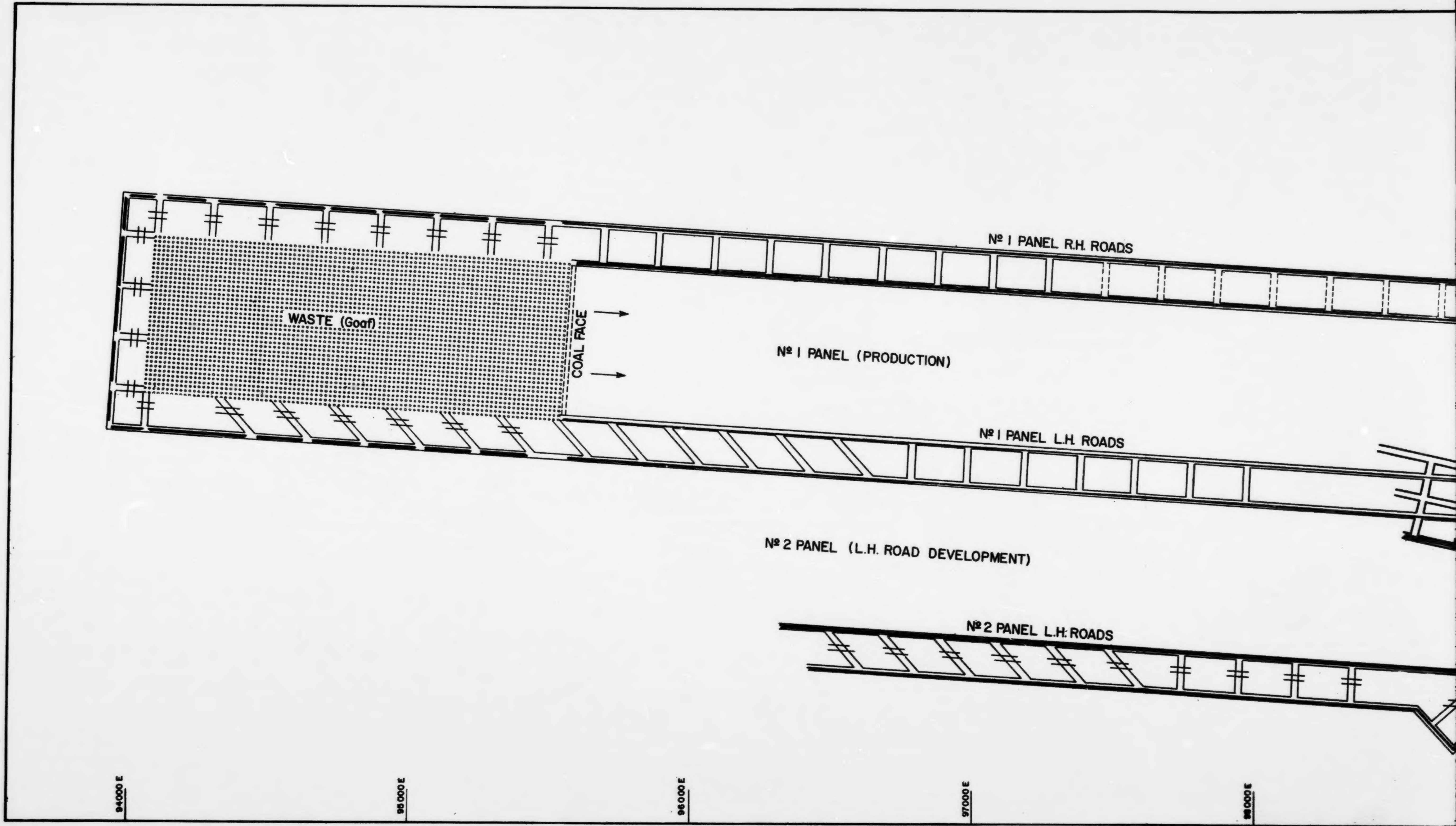
Level Surface Seam Inclination.	18°
δr	16°
δc	16°
δd	54°

McINTYRE MINES

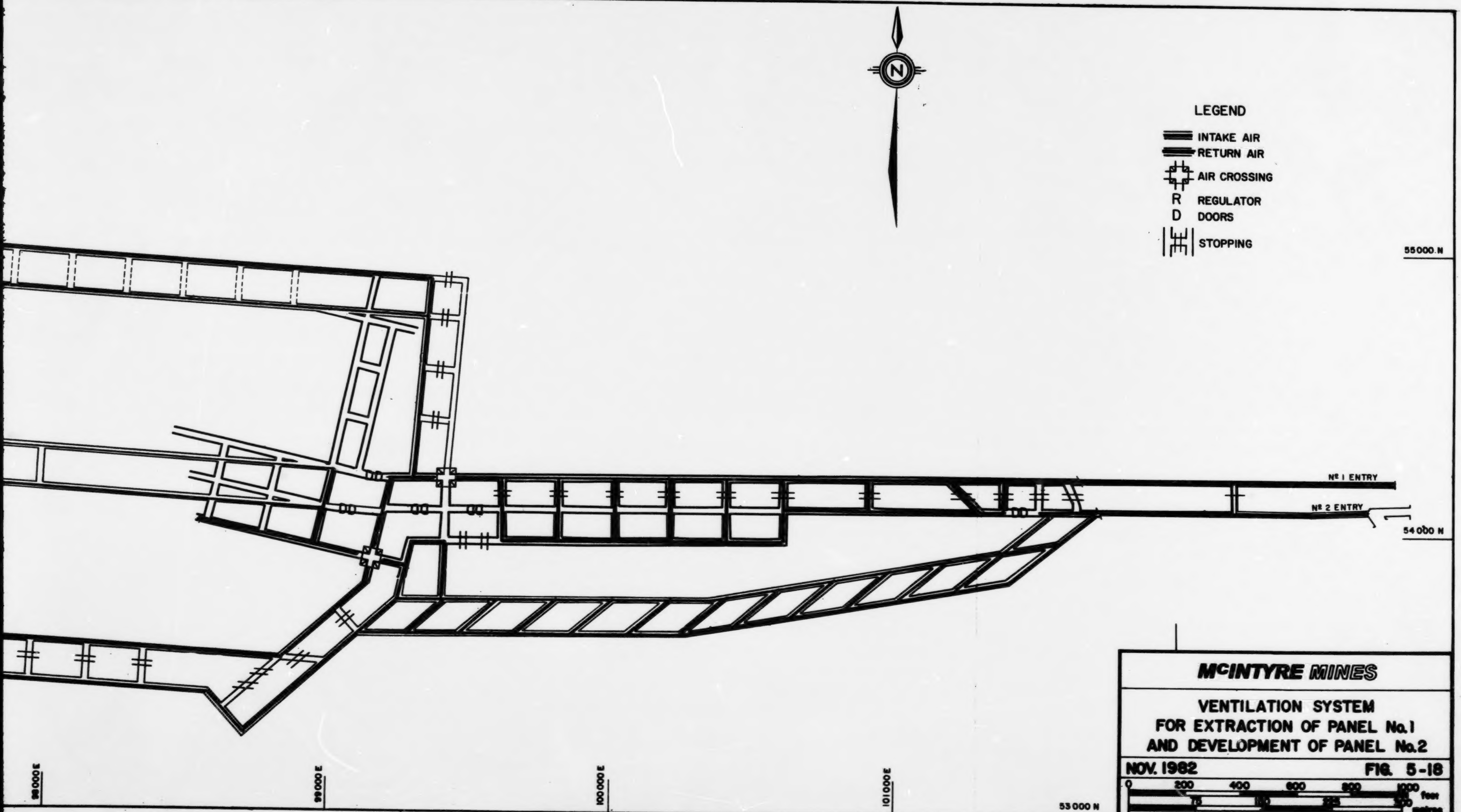
POTENTIAL SURFACE EFFECT

NOV. 1982 FIG. 5-11

Scale: N.T.S.



Nº I PANEL R.H. ROADS
WASTE (Goaf)
COAL FACE
Nº I PANEL (PRODUCTION)
Nº I PANEL L.H. ROADS
Nº 2 PANEL (L.H. ROAD DEVELOPMENT)
Nº 2 PANEL L.H. ROADS
94000 E
95000 E
96000 E
97000 E
98000 E

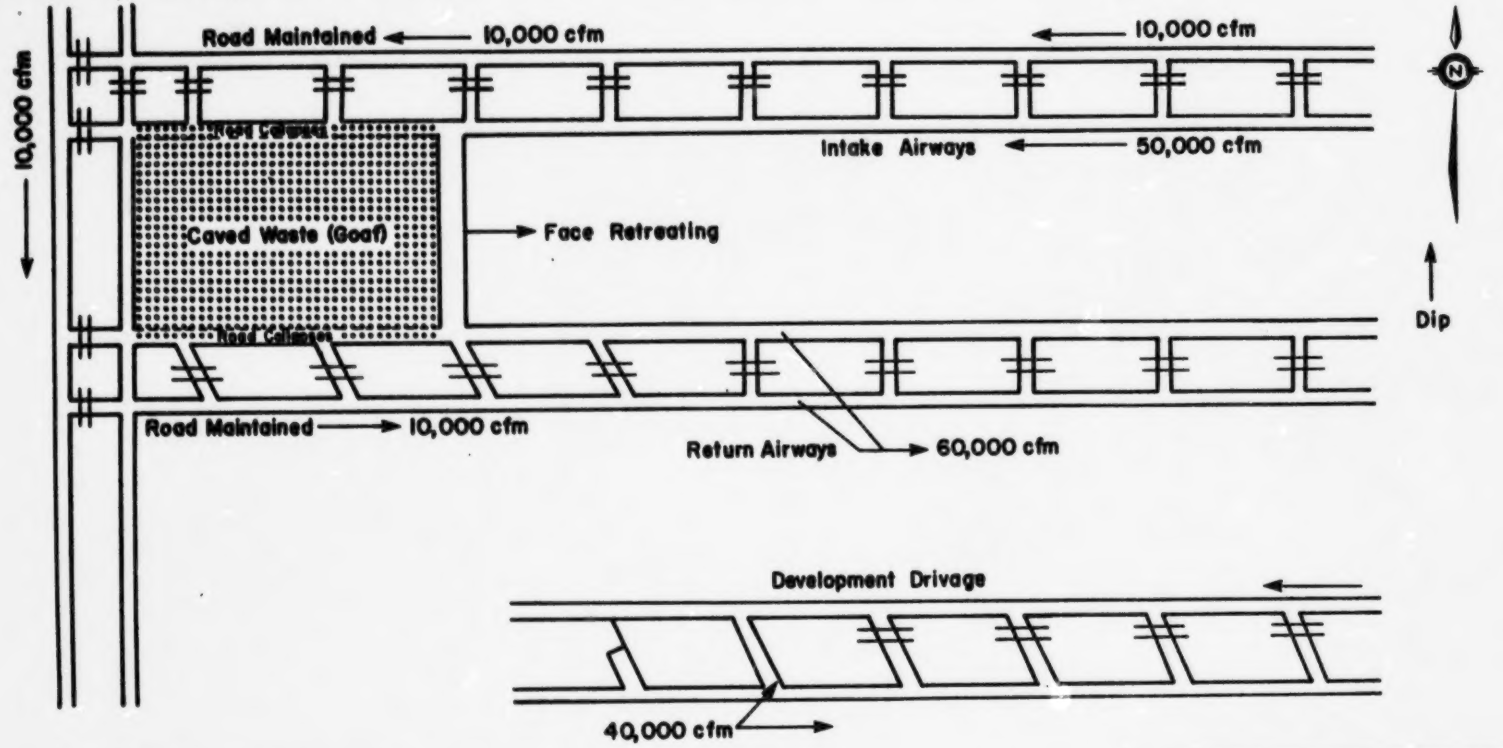

N
LEGEND
INTAKE AIR
RETURN AIR
AIR CROSSING
R REGULATOR
D DOORS
STOPPING
55000 N
54000 N
53000 N
Nº 1 ENTRY
Nº 2 ENTRY
98000 E
99000 E
100000 E
101000 E
0
200
400
600
800
1000
feet
75
150
225
300
metres

McINTYRE MINES

VENTILATION SYSTEM
FOR EXTRACTION OF PANEL No.1
AND DEVELOPMENT OF PANEL No.2

NOV. 1982

FIG. 5-18


Road Maintained
10,000 cfm
10,000 cfm
N
10,000 cfm
Road Collapses
Intake Airways
50,000 cfm
Caved Waste (Goaf)
Face Retreating
Dip
Road Collapses
Road Maintained
10,000 cfm
Return Airways
60,000 cfm
Development Drivage
40,000 cfm

VENTILATION REQUIREMENTS:

Development: 40,000 cfm
Face: 60,000 cfm
Total: 100,000 cfm
Volumetric Efficiency: 50%
Main Fan Quantity: 200,000 cfm

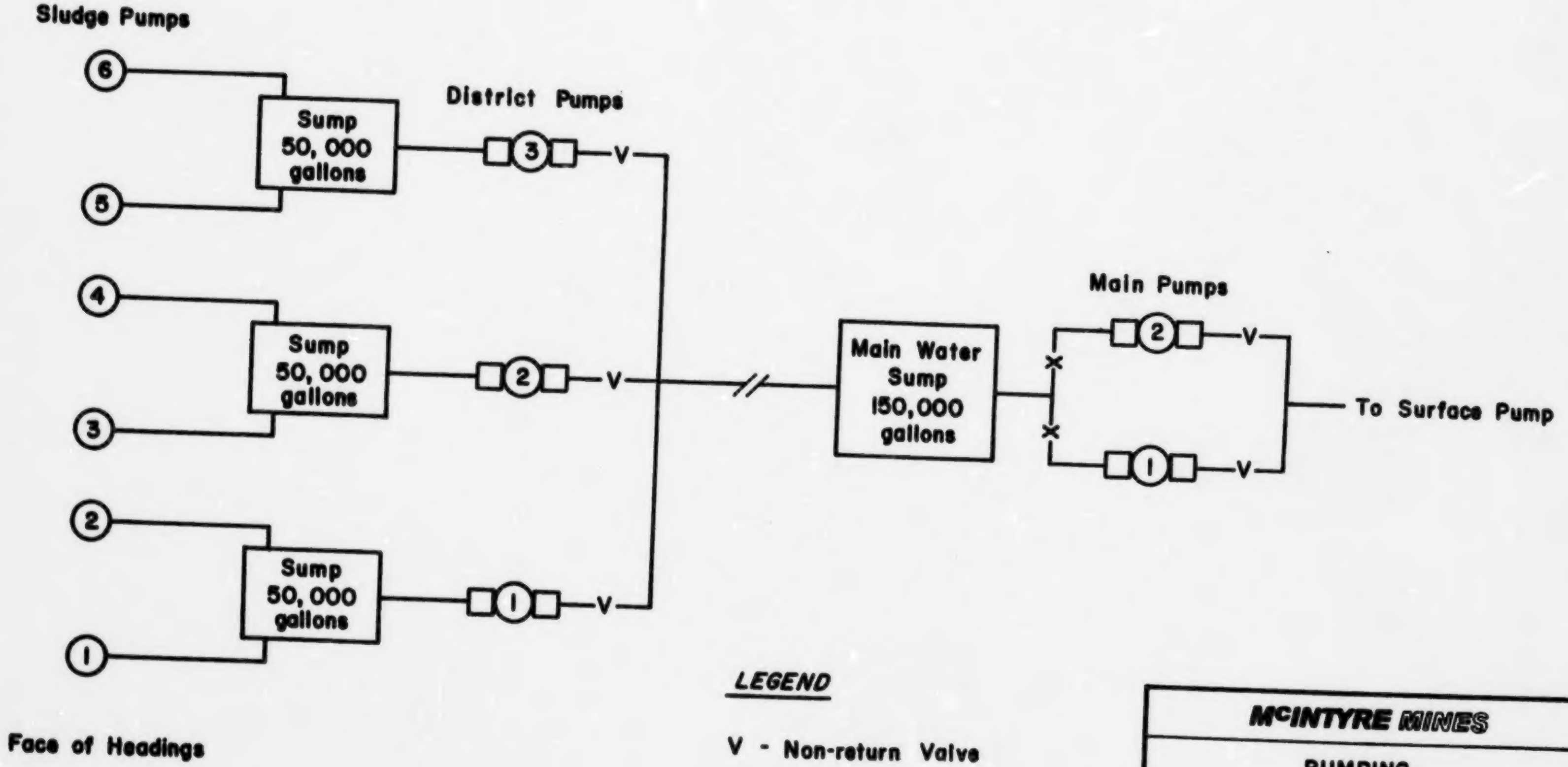
McINTYRE MINES

VENTILATION QUANTITIES
FOR LONGWALL OPERATION
AND DEVELOPMENT

NOV. 1982

FIG. 5-20

Scale: N.T.S.


Sludge Pumps
6
5
4
3
2
1
Face of Headings
Sump
50,000
gallons
Sump
50,000
gallons
Sump
50,000
gallons
District Pumps
3
2
1
V
V
V
Main Water
Sump
150,000
gallons
X
X
Main Pumps
2
1
V
V
To Surface Pump

LEGEND

V - Non-return Valve

X - Stop Valve

McINTYRE MINES

PUMPING
SCHEMATIC DIAGRAM

NOV. 1982

FIG. 5-24

Scale: N.T.S.

6.0 LONGWALL OPERATIONS

Successful longwall mining requires all phases from initial development to completion to be properly coordinated and controlled. Unscheduled delays can be extremely expensive, since a days delay may result in the loss of thousands of tons of production. Each phase of the operation must therefore be carefully planned and executed to maximize equipment utilization and keep delays to an absolute minimum.

Existing equipment and current mining techniques at Smoky River will be employed to develop the twin entry roadway systems and the face-line for Panel #1. Increased seam gradients will be encountered in the drivages required for Panel #2 and it is planned to employ a different type of heading machine so that the roof of the seam across the drivage remains substantially undisturbed.

The longwall equipment will vary in detail depending on the supplier, but in general the system will encompass:

- A hydraulically operated roof support system extending throughout the face and across the intake and supply roadways. The roof supports will be of the shield or chock shield configuration.
- An armoured face conveyor with double strand conveyor chain extending throughout the face and discharging to a stage loader in the intake roadway. The conveyor will accommodate a shearer and shearer haulage system and will have attachments for the powered supports.
- A double ended ranging drum shearer will mine the coal and transfer it to the face conveyor. The shearer will be mounted on a suitable underframe and be capable of travelling throughout the length of the face conveyor. The shearer will be electrically powered, equipped with hydraulic haulage, a lump breaker and comprehensive dust control systems.
- A stage loader of similar construction to the face conveyor will accept coal from the face conveyor. The stage loader structure

will accommodate a lump breaker and belt conveyor return end and be capable of retraction by mechanical or hydraulic means as the longwall retreats.

- Either as an intrinsic part of the stage loader assembly, or as a separate structure capable of ready retraction, accommodation for switchgear, transformers and other control equipment will be provided.

The equipment specified will be able to accommodate a range of remote control and monitoring facilities.

DEVELOPMENT

In room and pillar mining at No. 9A-4 and No. 9G-4 Mines and other mines elsewhere roadways have been successfully driven in seams inclined at up to about 18°.

Twin entry developments with a roadway profile similar to that shown in Figure 6-1 are currently being driven successfully in a 14° inclined seam in the No. 9A-4 Mine's 3 West District. This is very similar to the conditions anticipated at the inbye end of the drivages for the first longwall face. This experience confirms that the required drivages can be successfully completed.

Mining System

Three sections would be worked to develop Panel #1. The equipment for each section comprising:

1 continuous miner
2 shuttle cars
1 Stamler Feeder
3 auxilliary ventilation fans
1 Fletcher roof bolter
1 belt conveyor

Following installation of the first longwall unit, development of replacement faces would be achieved using one development section working on two shifts.

Development Schedule

Initially three development sections would operate on three shifts per day. Following commencement of operations on Panel #1 this would reduce to one development unit operating at two shifts per day. Development on three shifts would advance 100 ft and produce 625 tons per day (Table 6-5, Figure 6-3).

EQUIPMENT INSTALLATION

Before the equipment is transferred into the mine, critical elements of the system would be erected at the surface to ensure compatibility and to provide training facilities.

A compatibility trial and limited surface training would require about 3 to 4 weeks. During this time the longwall face support equipment would be installed and commissioned, including:

- The conveyor drives and automatic loop take-up for the main gate belt.
- The remote pumping station, tanks, emulsion mixing systems and supply lines.
- The longwall face HT power supply system, cables and transformers.

Upon completion of the compatibility trial the longwall equipment would be dismantled and prepared for transportation into the mine. To minimize the time for equipping the longwall, installation would be undertaken from each roadway.

Face supports and conveyor equipment would be transported to the face-line via the return roadway and transported down the face for installation. At the same time equipment such as the shearer, main face-conveyor drive unit, stage-loader, control switchgear and gate road supports would be transported along the intake roadway for installation.

A typical installation schedule conservatively based upon the installation of one face support and associated equipment in each operating shift is shown in Figure 6-4. Installation is estimated to take 8 weeks.

LONGWALL OPERATIONS

To ensure success the longwall will be subject to continuous scrutiny and attention to detail.

- The face will be maintained in a straight line.
- Maintenance will be performed at prescribed intervals.
- Minor faults on equipment will be rectified immediately.
- Mining standards will be maintained and the desired sequence consistently followed.

Failure to comply with such basic operational rules can result in an eventual production loss.

The sequence of operations that will be implemented will ensure that:

- Most of the coal is removed while mining from intake to return. The major portion passes under the machine and through the machine lump breaker so minimizing problems caused by large lumps of coal on the conveyor system.
- The conveyor and supports are advanced in sequence from intake to return-end, up-gradient. This will assist in controlling conveyor creep down the face-line.
- Persons employed on the shearer and support operations work in the intake airstream.

To ensure that mining operations can proceed without interruption:

- The road-heads will be properly prepared and sufficient room provided for shearer snake and conveyor advance.
- The stage loader and conveyor system will be prepared for retraction as the face retreats.
- All surplus material such as water pipes, cables, belt structure, etc. which become redundant as the face retreats will be removed on a regular basis.

While geological and geotechnical data indicate that major disturbances will not be encountered during mining operations, the possibility does exist that small faults, rolls, small areas of weak roof and floor and excessive water on the face may be encountered. These possibilities were taken into account in developing equipment specifications and the equipment purchased will be sufficiently flexible to combat hazards of this nature.

TRANSFER OF EQUIPMENT

Following completion of each panel the equipment must be transferred in total to equip the replacement panel. The transfer must be properly planned, scheduled and controlled in a similar manner to the initial installation.

Before each a panel is mined-out each item of equipment to be transferred will be carefully examined to determine if it requires overhaul or minor repair. Based upon the results of such examinations a decision on the repair/overhaul will be made to ensure that this is completed before transfer or before re-installation.

LONGWALL PERFORMANCE

Coal production from longwall operations can be influenced by many factors. The most severe interruptions to production usually occur as a result of abnormal geological conditions. The geological and geotechnical data for the proposed site indicate that the mining conditions will be reasonable. Provided operations are conducted in an efficient and orderly manner no significant delays occasioned by difficult mining conditions are anticipated.

To achieve the required levels of production on a continuous basis the workforce and supervisory personnel must be familiar with the equipment and mining system. In addition to initial training provided there would be a "run in" period during which minor modifications to the system may be required and the workforce becomes familiar with the equipment and systems. Table 6-1 provides general data for the calculation of longwall production performance.

Production levels which can be attained by operating the system on a 5-day week 3 shift per day basis are shown in Table 6-2.

DEVELOPMENT, PRODUCTION AND MANPOWER SCHEDULES

Based on the development capability of existing development equipment, anticipated longwall performance and manpower requirements a development and production schedule (Figure 6-3) and a manpower deployment schedule (Table 6-4) have been prepared.

Table 6-5 provides in summary form the basic data used to derive the development and production schedules and Table 6-6 identifies manpower required for longwall and total mine operations.

The development and production schedule and productivity summary show that:

- The first longwall face will be developed and ready to accept longwall equipment after 170 working days.
- Replacement longwall faces will be made available in ample time.
- During the demonstration period development crews would be available from the manpower allocated to develop access to additional resources.
- Annual production during the demonstration period in tons of clean coal will be:

° Year 1	312 135
° Year 2	728 978
° Year 3	749 789
° Year 4	611 472
° Year 5	358 012

- Output per manshift would be about 8.85 tons of clean coal equivalent in year 1, increasing in years 2 through 5 to an average of about 19 tons for the total demonstration period.

The schedules have been used as the basis for the economic evaluation of the project (Section 9).

TABLE 6-1

McINTYRE MINES LIMITED

LONGWALL PERFORMANCE GENERAL DATA

PANEL #1

ITEM		VALUE	REMARKS
1. Panel		1	
2. Duration of Mining		Retr.	
3. Seam		4	
4. Gradient	(degrees)	18-4	
5. Worked Height	(feet)	10	
6. Face Length	(feet)	550	
7. Panel Length	(feet)	4800	
8. Web Depth	(feet)	2.25	
9. Shearer type		DERDS	
10. Shifts per Day		3	
11. Travel Time*	(mins)	60	
12. Meal Time	(mins)	30	
13. A.W.T. per Shift	(mins)	390	
14. A.W.T. per Day	(mins)	1170	
15. Manshifts per Day	(face)	56	Includes overtime at 12%
16. Manshifts per day	(overall)	168	
17. Yield of Clean Coal	(percent)	72.5	

A.W.T. Available Working Time
Weight 26 cubic feet per ton

* Includes 10 minutes preparation time.

TABLE 6-2

McINTYRE MINES LIMITED

LONGWALL PANEL STATISTICS

REFERENCE		MACHINE CAPACITY	PROJECTED PRODUCTION	ANTICIPATED PRODUCTION
18. Tons per Shear		476	476	476
19. Cutting Rate	(ft/min)	25	18	-
20. Max Load on AFC	(tons/hr)	908	654	654
21. Cycles per Shift		4.6	3.82	3.06
22. Cycles per Day		13.8	11.46	9.18
23. Output per Shift	(LTR)	2190	1818	1457
24. Output per Day	(LTR)	6569	5454	4370
25. Advance per Shift	(feet)	10.35	8.6	6.90
26. Advance per Day	(feet)	31.00	25.8	20.7
27. Advance per Week	(feet)	155	129	103.5
28. Panel Life	(days)	155	186	232

TABLE 6-4

MANPOWER AND PRODUCTION SUMMARY
DEMONSTRATION PERIOD (5-YEAR)

DAYS		146	24	40	198	12	22	40	190	61	40	272
DURATION		0 - 146	146 - 170	170 - 210	210 - 408	408 - 420	420 - 442	442 - 482	482 - 672	672 - 733	733 - 773	773 - 1045
Manpower												
Development	Hourly	90	90	20	20	20	20	20	20	-	-	-
	Staff	9	9	2	2	2	2	2	2	-	-	-
	Total	99	99	22	22	22	22	22	22	-	-	-
Longwall	Hourly	-	-	60	56	56	56	56	56	56	56	56
	Staff	-	-	6	7	7	7	7	7	7	7	7
	Total	-	-	66	63	63	63	63	63	63	63	63
Others	Hourly	33	33	33	33	33	33	33	33	33	33	33
	Staff	21	21	21	21	21	21	21	21	21	21	21
	Total	54	54	54	54	54	54	54	54	54	54	54
Total	Hourly	123	123	123	109	109	109	109	109	89	89	89
	Staff	30	30	29	30	30	30	30	30	28	28	28
	Overall	153	153	142	139	139	139	139	117	117	117	117
Daily Production (LTR)	Development	1 875	1 250	412	417	-	417	417	417	-	-	-
	Face	-	-	-	4 370	4 370	4 370	-	4 370	4 370	-	4 370
	Total	1 875	1 250	417	4 787	4 370	4 787	417	4 787	4 370	-	4,370
Daily Production (LTC)	Total	1 354	906	302	3 470	3 168	3 470	302	3 470	3 168	-	3 168

TABLE 6-5

DEVELOPMENT AND PRODUCTION SCHEDULE PARAMETERS

The development and production schedules are built up on the following criteria:

1.	Days in the year	52 x 5	260
2.	Effective work days		233
3.	Face transfers (work 7 day week: 56 days)		40

Development Rates in all Drivages

1.	Feet per day	100
2.	Tons per foot	6.25
3.	Tons per day	625

Production Schedule (Longwall)

During the initial phase of operations of each longwall panel there will be a "running in" period during which production levels will be reduced.

It is estimated that this period will extend for some 20 days and that for the first 10 days one shear per shift will be achieved and for the second ten days two shears. The average daily production would be reduced by approximately 3% from 4370 to 4224 LTR per day. Since the longwall production levels used are already de-rated by 20% and conservative rates are used for development performance this is not considered significant and the base case production and development rates have beeen applied to derive the appropriate development and production schedules (Figure 6-3).

Tons Per Strip

Face length	feet	550
Mining height	feet	10
Strip	feet	2
Coal (weight)	cu. ft/ton	26
Tons per Strip	550 x 10 x 2.25 ÷ 26 tons	476

TABLE 6-6

TYPICAL MANPOWER DEPLOYMENT SUMMARY
LONGWALL WITH ONE THREE SHIFT DEVELOPMENT OPERATION

LONGWALL FACE	SHIFT		
	D	A	N
Shearer Operator	2	2	2
Supports Movement	3	3	3
Intake Roadhead	2	2	2
Return Roadhead	2	2	2
Support Maint.	1	1	1
Mechanic	1	1	1
Electrician	1	1	1
Stage Loader	1	1	1
Between Shift Maint.			4
Supervisors (Fireboss)	2	2	3
TOTAL	15	15	20

LONGWALL DISTRICT	SHIFT		
	D	A	N
Roadway Preparation			
Intake	2		
Return	2		
Salvage	3		
Methane Drainage			
Supplies Transport	2	2	2
TOTAL	9	2	2

DEVELOPMENT	SHIFT		
	D	A	N
Miner Operator	2	2	2
Roof Bolt	2	2	2
Shuttle Car	2	2	2
Side Support	1	1	1
Mechanics	1	1	1
Electrician	1	1	1
Supplies	1	1	1
Fireboss	1	1	1
TOTAL	11	11	11

OUTBYE WORKERS	SHIFT		
	D	A	N
Road Repair		2	2
Belt Patrol	2	2	2
Pumps	1		
Ventilation	2		
Fireboss	1	1	1
Senior Foremen	1	1	1
TOTAL	7	6	6

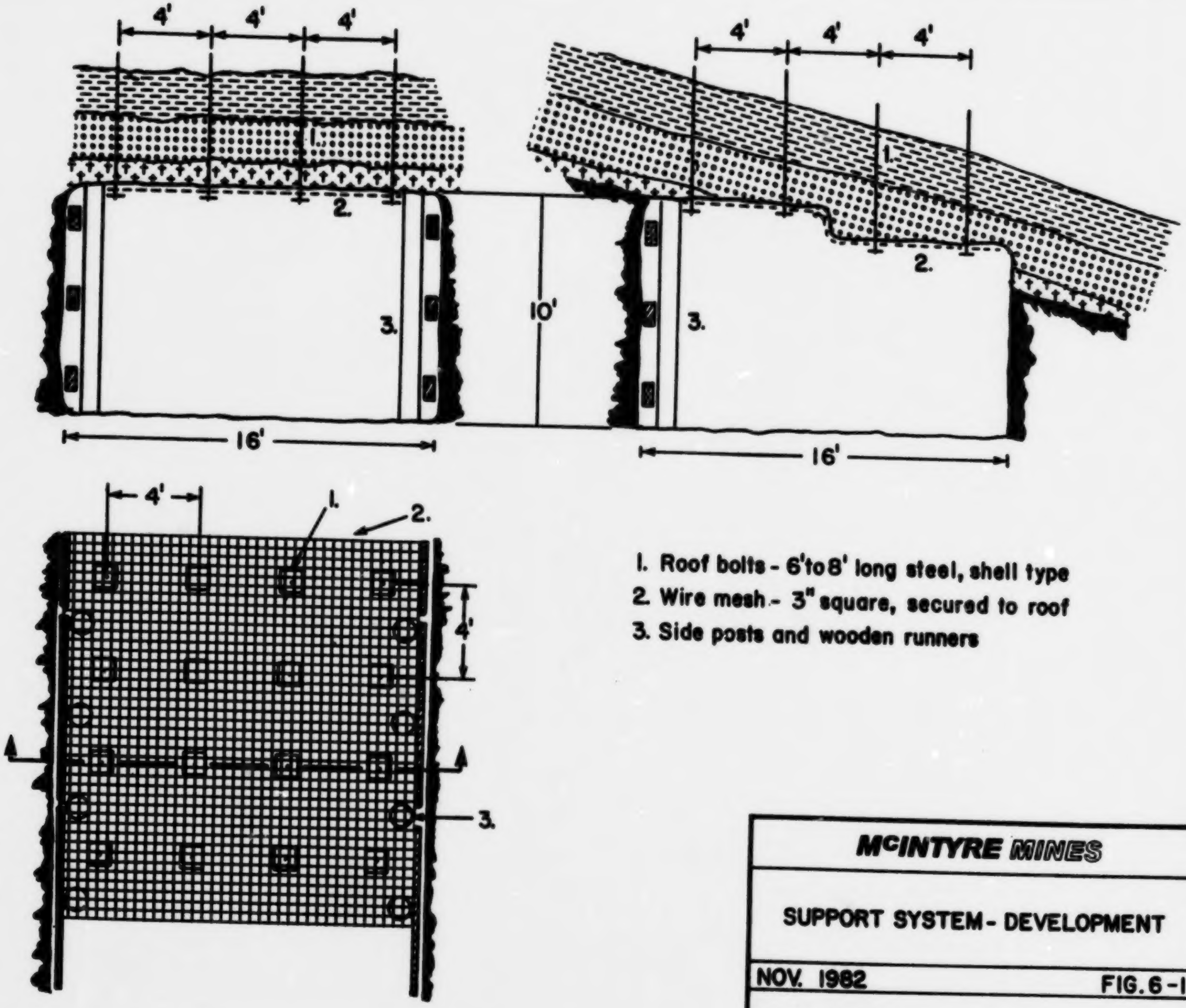
9G SURFACE	SHIFT		
	D	A	N
Portal & First Aid	1	1	1
Drivers	1	1	1
Foreman Mechanic	1	1	1
Electric	1	1	1
Janitors	1		1
TOTAL	5	4	5

WORKSHOP	SHIFT		
	D	A	N
Mechanic	2	2	2
Electrician	2		
Welder	1	1	1
Machine Operator	1		
TOTAL	6	3	3

OTHERS	SHIFT		
	D	A	N
Planner	1		
Surveyor	2		
Air Dust, etc.	1		
Safety/Rescue	1		
Clerk	1		
Training			
Elect. Mech.	2		
Undermanager	1		
TOTAL	9		

SUMMARY	SHIFT		
	D	A	N
Longwall Face	15	15	20
Longwall District	9	2	2
Development	11	11	11
Outbye: E.B.G.	7	6	6
Surface 9G	5	4	5
Workshop	6	3	3
Others	9		
TOTAL	62	41	47
	150		

EBG - Elsewhere below ground


4'
4'
4'
1.
2.
3.
10'
16'
4'
4'
4'
1.
2.
3.
16'
4'
1.
2.
4'
3.

1. Roof bolts - 6' to 8' long steel, shell type
2. Wire mesh - 3" square, secured to roof
3. Side posts and wooden runners

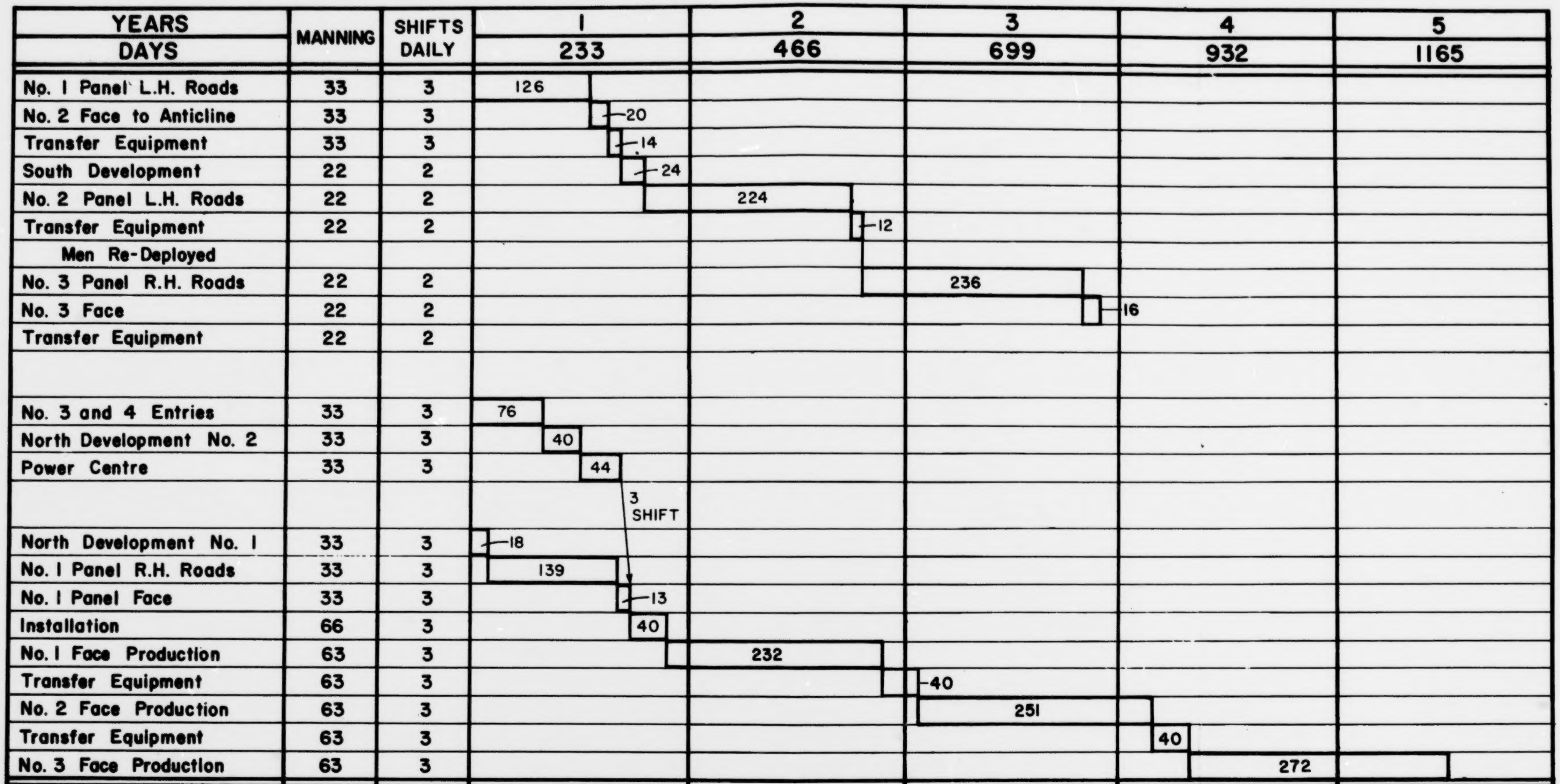
McINTYRE MINES

SUPPORT SYSTEM - DEVELOPMENT

NOV. 1982

FIG. 6 - 1

Scale: N.T.S.



YEARS	MANNING	SHIFTS DAILY	1	2	3	4	5
DAYS			233	466	699	932	1165
No. 1 Panel L.H. Roads	33	3	126				
No. 2 Face to Anticline	33	3	20				
Transfer Equipment	33	3	14				
South Development	22	2	24				
No. 2 Panel L.H. Roads	22	2		224			
Transfer Equipment	22	2		12			
Men Re-Deployed							
No. 3 Panel R.H. Roads	22	2			236		
No. 3 Face	22	2				16	
Transfer Equipment	22	2					
No. 3 and 4 Entries	33	3	76				
North Development No. 2	33	3	40				
Power Centre	33	3	44				
			3 SHIFT				
North Development No. 1	33	3	18				
No. 1 Panel R.H. Roads	33	3	139				
No. 1 Panel Face	33	3	13				
Installation	66	3	40				
No. 1 Face Production	63	3		232			
Transfer Equipment	63	3			40		
No. 2 Face Production	63	3			251		
Transfer Equipment	63	3				40	
No. 3 Face Production	63	3				272	
Annual Production LTR LTC			430,531 312,135	1,005,487 728,978	1,034,192 749,789	843,410 611,472	493,810 358,012

NOTE: THE NUMBERS ON THE BARS INDICATE DAYS.

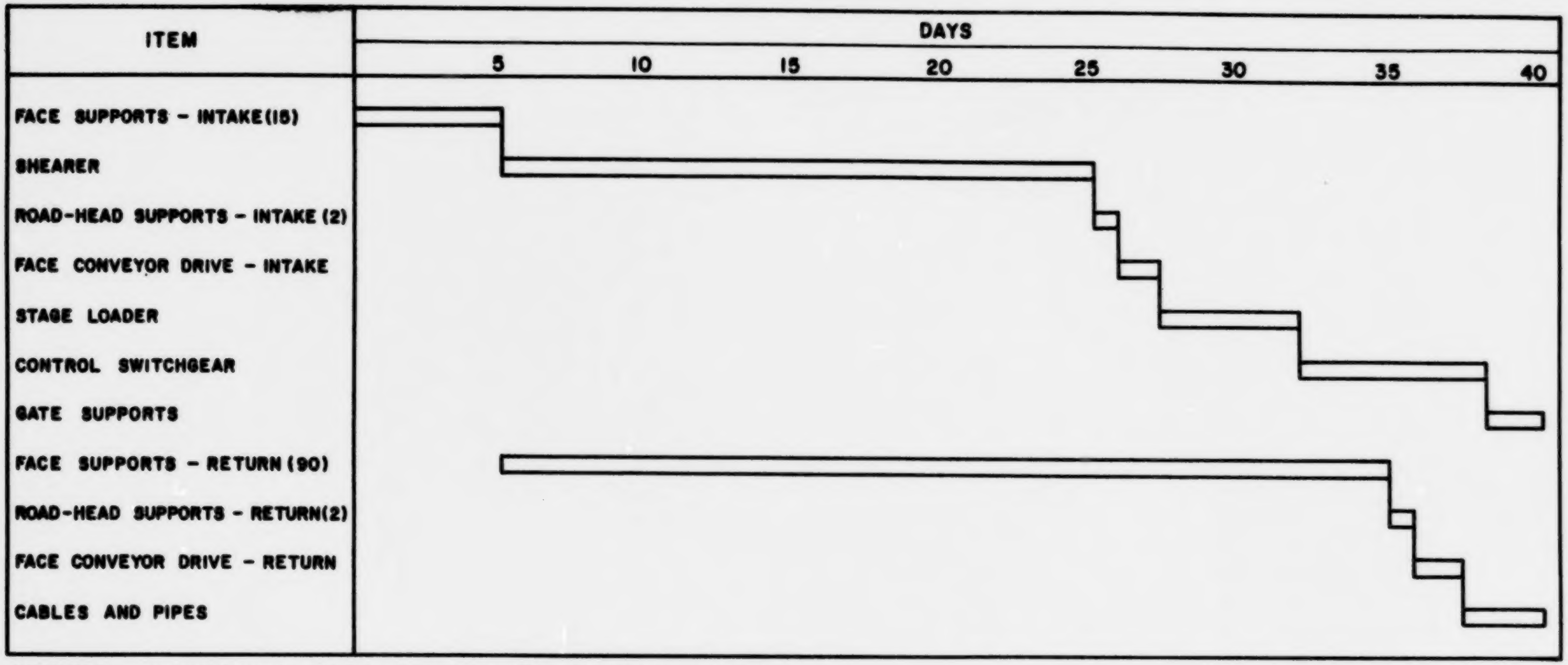
McINTYRE MINES

DEVELOPMENT AND PRODUCTION SCHEDULE
DEMONSTRATION PERIOD (5 YEAR)

NOV. 1982

FIG. 6-3

Scale: N.T.S.



REQUIRES · 1/ HYDRAULIC POWER INSTALLED PRIOR TO FACE INSTALLATION

2/ INSTALLATION PROCEEDS ON CONTINUOUS BASIS

McINTYRE MINES

LONGWALL EQUIPMENT
INSTALLATION SCHEDULE

NOV. 1982

FIG. 6-4

7.0 LONGWALL EQUIPMENT TENDERS

Section 7 discusses preparation of an invitation to tender for the supply of longwall equipment and assessment of tenders received.

EQUIPMENT SPECIFICATION

A comprehensive site specific longwall equipment specification was prepared, this specification with relevant geological, geotechnical and other supporting data formed the basis for an enquiry document which was issued as an invitation to tender to six selected manufacturers for the supply and installation of a complete longwall system and supporting services.

To minimize risk, operating parameters and equipment performance levels were specified that can be readily achieved with the current generation of longwall mining systems.

Though conservative this approach is prudent in view of the importance of a successful longwall demonstration. The advantages of this approach are numerous and include:

- The systems selected will employ technology proven at other mines.
- The systems can be critically previewed in operation at other mines.
- The operating experience gained at other mines can be assimilated before installation at Smoky River.
- Equipment malfunction should be minimal.
- The learning process associated with new technology will be minimized.

- Since the equipment is being routinely manufactured, capital cost will be minimized.

ASSESSMENT OF TENDERS

In response to the invitation five manufacturers submitted detailed and comprehensive tender documents. The sixth manufacturer formally declined the invitation to tender.

No single tender fully addressed the parameters outlined in the enquiry document. As a result direct comparison of tenders is not possible but each tenderer provided sufficient detailed information to form a sound basis for negotiation if a decision to proceed with the longwall installation is made.

Technical Assessment

To maintain commercial confidentiality each tenderer has been assigned a discrete identification letter from A to E. A comparison of the various items offered are contained in Tables 7-2 to 7-8.

In McIntyre's view the most important element in the tenders is the roof support system. The correct choice of support will determine the success or failure of the project. Each tenderer fully addressed this subject and provided detailed submissions for both longwall and roadhead supports.

Before a final selection can be made each tenderer should, following technical discussions to define more closely the scope of the tender document, be invited to submit an amended tender which would allow a comparative evaluation to be made. Following the tender discussions and prior to receipt of the amended tenders the opportunity should be taken to visit longwalls at locations where equipment of similar design to that proposed for use at Smoky River is operating.

Assessment of Capital Cost

As several areas specified in the enquiry document were addressed in varying degrees of detail (Table 7-1) and alternative equipment proposed in some instances, possible combinations of cost made it extremely difficult to arrive at a total for a system which fully met the requirements of the enquiry document.

To arrive at a total cost for a system which complied with the enquiry document, a composite cost for the system was assessed as $12.5 million using cost data supplied by tenderers.

TABLE 7-1

TENDER COMPARISON SUMMARY

ITEM	SUPPLIER A	SUPPLIER B	SUPPLIER C	SUPPLIER D	SUPPLIER E
SHEARER					
a) Machine	2 types	1 type	3 types	3 types	1 type
b) Haulage System	2 systems	1 system	3 systems	3 systems	2 systems
c) Lump Breaker	1 type	1 type	1 type	1 type	1 type
POWERED SUPPORTS					
a) Type	1 type (4 leg chock shield)	2 types (4 leg shield & chock)	3 types (2 leg shields)	2 types (2 leg & 4 leg shield)	1 type (4 leg shield)
b) Extras	Forepole & face sprag	Forepole & face sprag	Forepole & face sprag	Forepole & face sprag	Forepole & face sprag
c) Control Equipment	Single adjacent	Bi-di adjacent	N.S.	Single adjacent	Bi-di adjacent
d) Power Pack	1 type	1 type	1 type	1 type	1 type
FACE CONVEYOR (AFC)					
a) Type	1 type	1 type	2 types	1 type	1 type
b) Ancilliaries	Full range	Full range	Full range	Full range	Full range
STAGE LOADER					
a) Type	2 types	1 type	2 types	1 type	2 types
b) Lump Breaker	1 type	1 type	1 type	1 type	2 types
c) Belt Conveyor R.E.	1 type	1 type	1 type	1 type	Crawler mounted
BELT CONVEYING SYSTEM					
a) Type	Drive, auto loop take-up	Drive, auto loop take-up	N.S.	Drive, R.E., Storage unit	1 type - Rigid Structure
EQUIPMENT TRANSPORTER	Manufacturer reference provided	Not stated	1 type	Railed transport system	1 type - MSHA approval
ELECTRICAL EQUIPMENT	Switchgear and cables	Complete system & data transmission	Complete system & data transmission	3 systems	N.S.
TRAINING PROGRAM	Consultant reference provided	Training program	N.S.	Site training program	Not detailed - cost quoted
EQUIPMENT COST (TYPICAL)	12,119,936.00 C.I.F. Mine Site	12,030,985.00 C.I.F. Sidney N.S.	12,156,000.00 F.O.B. Mine Site N.B. Cost Selected From Multiple Alternatives	12,088,000.00 F.O.B. Mine Site N.B. Cost from Multiple Alternatives	11,507,240.00 F.O.B. Port of Lading

TABLE 7-2

LONGWALL FACE EQUIPMENT SPECIFICATION SUMMARY

ITEM	SUPPLIER A		SUPPLIER B		SUPPLIER C			SUPPLIER D			SUPPLIER E	
Shearer: Make	A.S.	D.J.D.	A.S.		A.S.	Eichoff	Mitsui	A.S.	Eichoff	Mitsui	Mitsui	
Power H.P.	500	480	500		500	467	400	500	467	400	400	
Haulage Speed fpm	22	0-15	22		22	29	28	22	28	28	28	
Haulage System	Roll rack	Multi-drive	Roll rack		Rollrack	Eicotrack	Pinrack	Rollrack	Eicotrack	Pinrack	Pinrack (or Eicotrack)	
Drum Spec	66"PFF-HSV	66"PFF-HSV	66" PFF-HSV		66"PFF-HSV	78"PFF-HSV	72"HSV-PFF	66"HSV-PFF	78"HSV-PFF	72"HSV-PFF	72" HSV-PFF	
Supports: Type	Chock Shield		Chock Shield	Shield	Shield	Shield	Shield	Shield	Shield		Shield	
Total load legs - tons	4 - 600		4 - 650	4 - 650	2 - 500	2 - 500	2 - 500	2 - 575	4 - 575		4 - 550	
Range: Max. ins.	168		150	150	149	149	149	150	150		149	
Min. ins.	80		71	71	68	68	65	72	72		90	
Weight tons	20		14	14	22	22	22	17.5	17.5		14	
Gradient (max.)	30°		35°	35°	30°	30°	30°	N.S.	N.S.		Flat to Medium Inclined	
Floor Pressure at Yield psi	330		363	363	306	306	215	435	353		277	
Roof Pressure at Yield psi	180		197	197	126	126	125	168	129		200	
Control Valves	Adjacent - Unidi		Adj. Bidi	Adj. - Bidi	N.S.	N.S.	N.S.	Adj. - Unidi	Adj. - Unidi		Adjacent - Bidi	
Position of Support	Conventional - 1 Web back		Conventional	Conventional	1 web back	1 web back	Conven. or 1 web	Conventional	Conventional		Conventional or 1 web back	
Base Lifting Facility	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes		N.S.	
Feature			Capsule set extension	Wedge set extension	Split base	Solid base	Solid base					
Face Conveyor: (Profile)	Sigma		Sigma		Sigma		Sigma	Sigma			Box	
Line Pan height ins.	10.5		10.5		9.08		9.5	10.39			10.6	
width ins.	38.6		38.6		30.7		33	34.13			31.5	
Chain size and type	26 mm outboard		26 mm outboard		26 mm inboard		26 mm inboard	30 mm inboard			26 mm inboard	
Speed	200		210		213		258	224			217	
Capacity tph	1000		1000		1000		1000	1000			1000	
Stage Loader: (Profile)	Sigma		Sigma		Sigma		Sigma	Sigma			Sigma	Sigma
Line Pan Height ins.	10.5		10.5		9.08		9.5	10.39			8.75	8.1
Width ins.	38.6		38.6		30.7		33	34.13			30	31.5
Chain size and type	26 mm		26 mm O.B.		26 mm I.B.		26 mm I.B.	30 mm I.B.			26 mm O.B.	26 mm I.B.
Speed	258		243		256		303	260			280	236
Capacity tph	1200		1280		1200		1250	1800			1820	1100

* N.S. Not Stated   PFF Pick Face Flushing   HSV Hollow Shaft Ventilation   OB Outboard   IB Inboard

TABLE 7-3

SHEARER SPECIFICATION SUMMARY

MAKE		ANDERSON STRATHCLYDE AM 500	EICHOFF EDW 300 L	B.J.D.	MITSUI MCLE 350 - DR 6565 M
Offered by		Suppliers A, B, C, & D	Suppliers C & D	Supplier B	Suppliers C, D & E
Power	H.P.	500	467	500	400
Haulage Speed Max.	fpm	22	28	15	28
Haulage System		Roll rack	Multi-drive	Eicotrack	Pinrack or Eicotrack
Drum size	ins.	66	78	66	72
Drum R.P.M.		25	27	23	27
Facilities		HSY - PFF	HSV - PFF	HSV - PFF	HSV - PFF
Methane Detector		Yes	N.S.	N.S.	N.S.
Prestart Warning		Water Coalflow	N.S.	Visible & Audible Available	N.S.

HSV Hollow Shaft Ventilation
PFF Pick Face Flushing
N.S Not Supplied

TABLE 7-4

SUPPORT SPECIFICATION SUMMARY

ITEM		SUPPLIER A	SUPPLIER B	SUPPLIER C	SUPPLIER D	SUPPLIER E
Type:		Chock Shield	Chock Shield	Shield	Shield	Shield
Load	(tons)	4 - 600	4 - 640	2 - 500	4 - 575	4 - 550
Height: Open	(ft)	14'	12' 6"	12' 6"	12' 6"	12" 5"
Closed	(ft)	6' 8"	5' 11"	5' 10"	5' 11"	7' 6"
Weight	(tons)	20	14	22		14
Control		Unidi - adjacent	Bidi - adjacent	-	Unidi - adjacent	Bidi adjacent available
Pressure	(psi)	4500 - 5612	4500 - 5812	4785 - 6090	4640 - 6100	4267 - 5007
Centres	(ins)	59	59	59	59	59
Support Density						
Before Cut	(psi)	154.5	166.4	158.6	171	99.6
After Cut	(psi)	131.5	140.0	126.0	141.5	200
Roof Bearing Yield	(psi)	180	197.6	125	129	200
Floor Bearing Yield	(psi)	330	363.2	215	353	277
Gradient	(max)	30°	35°	30°	Not quoted	Medium Inclined to Flat
Base						
Type		Rigid	Rigid	Solid	Catamaran	Rigid
Base Lifting		Yes	Yes	Yes	Yes	No Mention
Area	(ft^2)	29.5	27.4	36.3	23.6	30.9
Canopy						
Type		Rigid	Rigid	Articulated	Rigid	Rigid
Area	(ft^2)	53.9	50.4	44.6	45.5	42.8
Forepole max.	(tons)	15	15	20	16.8	15
Face Sprag max.	(tons)	4.5	6	9.3	4.4	7.4
Positive Set		Yes	Yes	Yes	Yes	Not Mentioned
Walkway		Offered	Offered	No	No	Not Mentioned
Anticreep		Yes	Yes	Yes	Yes	Not Mentioned
Legs		D.A. D.T.	D.A. D.T.	D.A. D.T.	D.A. D.T.	D.A. S.T.
Position:		Conventional or 1 Web back	Conventional	Conventional or 1 Web back	Conventional	Conventional or 1 Web back
Transport		Eimco 936 Diesel	No Offer	Wagner Diesel Scooptram and Philips Trailer	Beco Railer (Face only)	Eimco 936 Diesel

* DA - Double Acting
DT - Double Telescopic

TABLE 7-5

HYDRAULIC POWER SUPPLY SYSTEM SPECIFICATION SUMMARY

ITEM		SUPPLIER A	SUPPLIER B	SUPPLIER C	SUPPLIER D	SUPPLIER E
Make		Hauhinco	Gullick	Hauhinco	Hauhinco	Hauhinco
Pumps		3 of EHP 3K-60-40	2 of S 15	2 EHP 3K 90/45	3 of EHP 3K 110/45	3 of K90/110/45
Output	(gpm)	22	42	42	42 per pump	42 per pump
Pressure	(psi)	4500	4500	4500	4500	4500
H.P.		90 x 3	150 x 2	125 x 2	150 x 3	150 x 3
Emulsion Tank	(galls)	200 x 2		220 x 2	265	581.2 (U.S.) 3 of
Oil Tank	(galls)		450 1 of			26.4 (U.S.) 3 of
Surge Tank	(galls)				220	132.1 (U.S.) 3 of
High Pressure		5,000' Steel	5,000' Steel	5,000 x 1.5" dia. Steel	5,000 Steel	5,000' Steel
Return Pipe		5,000' Steel	5,000' Steel	5,000 x 2" Water Pipe	5,000 Plastic	5,000'
Dust Suppression Tank	(gal)		2 of 5150 450			

TABLE 7-6

FACE CONVEYOR SPECIFICATION SUMMARY

ITEM	SUPPLIER A	SUPPLIER B	SUPPLIER C	SUPPLIER D	SUPPLIER E
Type		A.S. Dreadnought 1500	American Longwall	UFv 34/700	MCCv - HB800
Profile	Sigma	Sigma	Sigma	Sigma S	Box
Pan Height (ins)	10.5 (268 mm)	10.5	9 1/2" (240 mm)	10.39" (264 mm)	10.6" (270 mm)
Pan Width (ins)	38.6	38.6	33" (834 mm)	34.13	31.5"
Conveyor Length (ft)	563	*578	571 ft	571 ft	542.7 ft
Deck Plate (ins)	1.18	1.2	1.25 ins	1.18 ins	2 x 0.625 ins.
Chain Speed (fpm)	208	210	258 fpm	224 fpm	217 fpm
Chain Size & Grade	26 mm (Din 22252)	26 mm (Din 22252)	26 mm (Din 22252)	30 mm	26 mm (C)
Capacity (tph)	1360	1000	1000	1000 tons per hour	1000 tons per hour
Motors: Main Drive HP	300	300	400	300	300
Tail Drive HP	300	300	400	300	200
Chain Assembly	Outboard	Outboard	Inboard	Inboard	Inboard
Bottom Covered	Covered	Covered	Covered	Hinged 5th pan Welded others	Boxed
Furnishings	Complete	Complete	Complete	Complete	Complete
Cable Handler	Bretby (Iron)	Bretby	Bretby	Bretby Mark II	
Spill Plate Height (ins)	40"	60"	30 3/4"	40.15"	39 3/8"

TABLE 7-7

STAGE LOADER AND BREAKER SPECIFICATION SUMMARY

ITEM	SUPPLIER A	SUPPLIER B	SUPPLIER C	SUPPLIER D	SUPPLIER E
STAGE LOADER					
Make	Dowty Meco	Anderson Strathclyde	American Longwall	UFv 34 1700	MCCv - H800
Profile	Sigma	Sigma	Sigma	Sigma	Sigma
Pan Height (ins)	10.55	10.5	9 1/2	10.39 ins	8.1" (206 mm)
Pan Width (ins)	38.6	38.6	33	34.13 ins	31.5" (800 mm)
Conveyor Length (ft)	69	131	75	76 ft	70.5 ft
Overlap (ft)	3.28	23		18 ft	varies
Chain Speed (fpm)	258	243		260 fpm	236 fpm
Capacity (rph)	1360	1280	1250	1500 tons per hr.	1100 tons per hr.
Chain Configuration	Outboard	Outboard	Inboard	Inboard	Inboard
Motor (hp)	150	150	150		
BREAKER		Klockner Becorit SB63		SB 160V	Crockett
Type	Impact	Impact	Vertical Drum	Impact	Vertical Drum
Motor (hp)		150	150	2 x 100	2 x 120
Capacity		1200	1000 - 2000	1800 tons per hr.	1500 tons per hr.
Deckplate	3"	2 1/2"	3"		

TABLE 7-8

ROADWAY CONVEYOR SPECIFICATION SUMMARY

ITEM		SUPPLIER A	SUPPLIER B	SUPPLIER C	SUPPLIER D	SUPPLIER E
Make		Dowty-Meco	Anderson Strathclyde		Long Airdox Lo Rope	Long Airdox Lo Rope
Head End Pulley	(ins)	16		No drive or loop included in the quotation	36	36
Drive head		150 BL			DT 36 H	DT 36 H
Motor	(hp)	150	2 x 350		2 x 350	2 x 350
Capacity	(tph)		1200		1200	1200
Loop Length	(ft)	80	Auto		Super 500 H.D.	Super 500 H.D.
Storage	(ft)				500	500
Belt Reeling		Yes (extra)	No	No	No	No
Return End		In Stage Loader Spec	Mobile (Included in S.L.)	Included in Stage Loader 42-HA-15-LV	Return Crawler Mounted	Return Crawler Mounted
Belt Width	(ins)	48	42	42	42	42
Belt Speed	(fpm)	600				600

8.0 MANAGEMENT OF A LONGWALL DEMONSTRATION PROJECT

PROJECT MANAGEMENT

It is likely that the only suitable location for a longwall demonstration would be within an existing mine, in order to take advantage of expertise and a market for the coal.

Consequently, since a longwall produces large volumes of coal (approximately 1 million raw tons per annum from one unit and associated development) it could provide a substantial proportion of the total output at the mine.

The major objectives of the demonstration project are to show that in Rocky Mountain conditions:

- Longwall provides a safer working environment than room and pillar.
- Reserves not presently recoverable by room and pillar can be mined by longwall.
- Longwall is economically viable.

A demonstration will provide a unique opportunity to:

- Initiate and conduct meaningful mining research programs.
- Collect and disseminate data related to the mining operation.
- Afford an opportunity to provide "hands on" training in all areas related to longwall mining operations.

The project management team must maximize the benefit to be obtained from this opportunity. To control the project a small team of competent engineers and technicians with clearly defined responsibilities and lines of communication is to be preferred to a committee since decisions which may affect the operational and research aspects of the project will be required on a day to day basis.

To guide the project team and monitor performance of the operation and research aspects of the project, a steering committee should be formed. Membership on this committee should be limited to those with a direct interest and involvement in the project and the committee should function under the chairmanship of a CANMET designated officer.

A proposed project management structure is shown in Figure 8-1. A proposed Project Steering Committee structure and terms of reference are shown on Table 8-1.

RECOMMENDATIONS FOR RESEARCH

The development and operation of a longwall mining system at Smoky River presents a unique opportunity to conduct research under controlled conditions. The following list identifies some of the areas where such research may be undertaken:

- Rapid drivage in inclined seams by either multiple or single entry systems.
- Convergence studies in roadways and pillars adjacent to longwall operations.
- Subsidence studies at the surface to derive meaningful parameters for Rocky Mountain conditions.
- Application of remote monitoring systems for environmental control and determination of the relationship between production and methane liberation.
- Alternative dust suppression techniques for both development and longwall systems.

- Application of high frequency strata monitoring devices to predict roof falls.
- Application of remote monitoring systems to provide management information on system performance.
- Application of methane drainage systems to reduce methane concentrations adjacent to longwall operations.
- Alternative roadway support techniques.
- The effect of improved illumination on operational performance and worker morale both in development drivage and longwall operations.
- Remote control of mining machines for longwall and development.
- Assessment of performance of support systems on the longwall and in roadways.
- Assessment of strata behaviour related to stress and pressure developed during longwall mining.

The variations in Panels #1 to #3 in relation to cover, gradient and geological disturbance are such that these factor related events could be identified within 4 years.

TRAINING

It is essential that supervisory, maintenance and operating staff are properly trained. The objective of the training program is to ensure that every person employed on the longwall mining operation is fully conversant with:

- The objectives of the project and the personal contribution required.
- The mining systems and the inter-relationship of each mining activity.

- The operating and safety characteristics of each item of equipment used.
- The methods of operation and control for each item of equipment used.

Program Development

Development and implementation of proper training programs requires a significiant period of time. Based upon the schedules for development and an assessment of quotations received, at least six months will elapse between placing of an order and equipment delivery. Provided that training program development is initiated at the time of placement of order no undue difficulty should be experienced.

The training program must encompass the needs of all the various skills necessary to operate the longwall system and can be subdivided into three discrete sections:

- Mining Supervisory Skills.
- Operator Skills.
- Maintenance Skills.

To take advantage of the available time and maximize training opportunities the program could be delivered in a phased manner:

- Phase 1: Visits to operating longwall installations with similar mining conditions and equipment.
- Phase 2: Following equipment delivery, conduct equipment familiarization and site specific training. This would be undertaken at the minesite and utilize selected sections of the actual equipment to be used erected at site for training purposes.
- Phase 3: Training during installation and early operation of the longwall.

A valuable benefit from a longwall demonstration is the ability to provide a 'hands on' training environment for the planning and operation of longwall systems to other interested coal mine operators. This would be of particular benefit to potential operators and greatly assist in the dissemination of longwall mining technology.

TABLE 8-1

PROPOSED STRUCTURE AND TERMS OF REFERENCE
PROJECT STEERING COMMITTEE

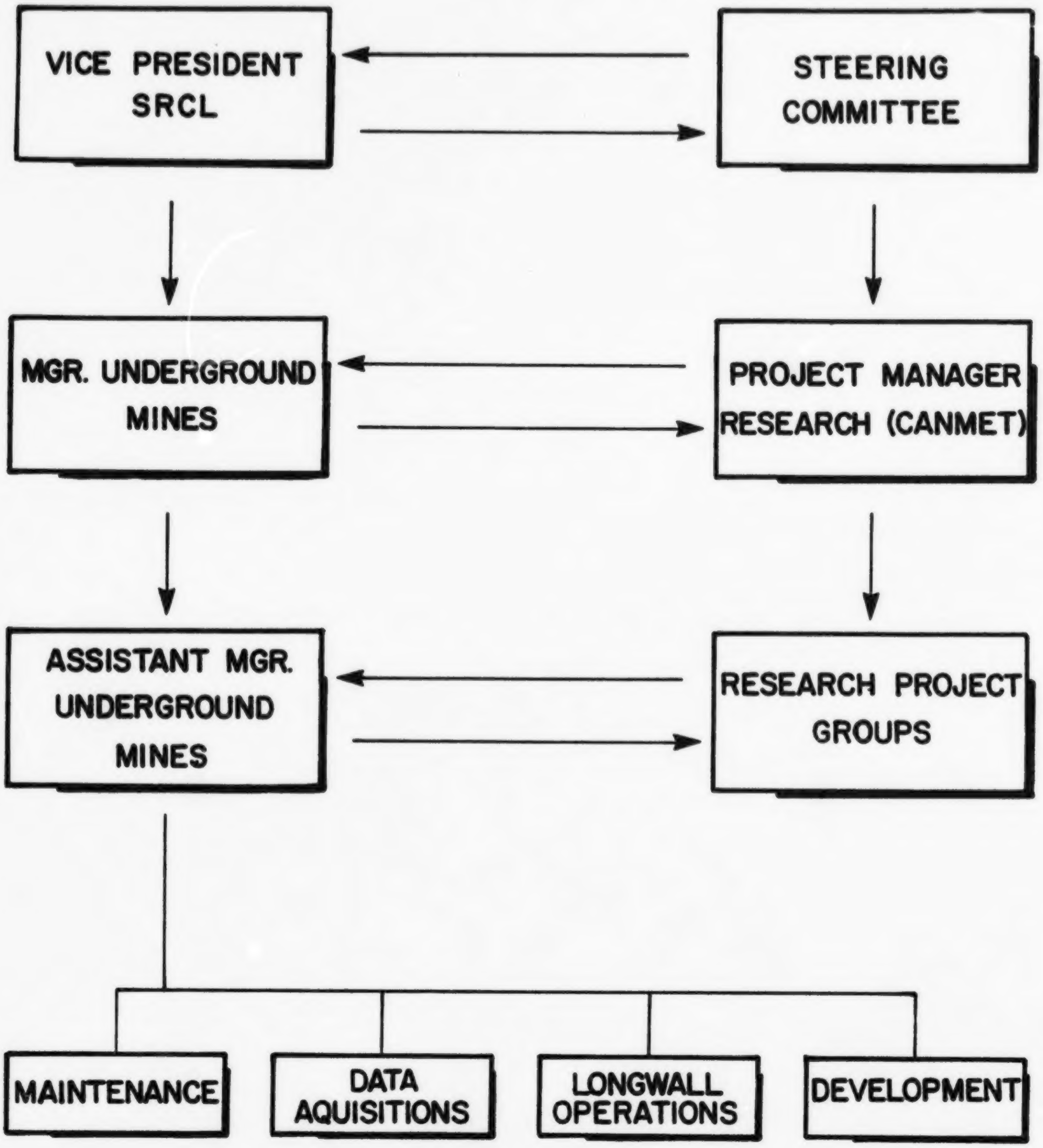
Chairman - CANMET Representative

Members - Department of Occupational Health and Safety
- Energy Resources Conservation Board
- Department of Energy, Mines & Natural Resources
- Coal Mining Research Council
- Coal Association of Canada, Research & Development
- Vice President, Smoky River Coal Limited

Ex Officios - Project Manager Research, CANMET
- Manager Underground Mines, Smoky River Coal Limited

Terms of Reference

1. Monitor the progress of the longwall trial.
2. Provide periodic and final assessment of the project.
3. Collate and disseminate information on the project.
4. Approve and co-ordinate additional on-site research.


VICE PRESIDENT SRCL
STEERING COMMITTEE
MGR. UNDERGROUND MINES
PROJECT MANAGER RESEARCH (CANMET)
ASSISTANT MGR. UNDERGROUND MINES
RESEARCH PROJECT GROUPS
MAINTENANCE
DATA AQUISITIONS
LONGWALL OPERATIONS
DEVELOPMENT

McINTYRE MINES

PROPOSED PROJECT
MANAGEMENT STRUCTURE

NOV. 1982

FIG. 8-1

Scale: N.T.S.

9.0 ECONOMIC EVALUATION

INTRODUCTION

This section provides projections of mining costs and an economic evaluation of longwall mining at No. 9G-4 Mine. Detailed cost assessments are provided relating to the mining and delivery of coal to a stockpile on the surface near the portals, embracing all aspects of the longwall mining process including development, production, maintenance and supporting services.

The costs for longwall at No. 9G-4 Mine form a basis from which potential operators could develop cost estimates for longwalling at other locations.

Non-direct costs such as coal preparation, administration, rail and port and the sales revenues received for the coal that are specific to the Smoky River operation have been used in the economic evaluation. In order to assess the economics of longwall at other locations, potential operators would have to substitute their site specific values.

Several approaches can be adopted when evaluating longwall mining. For example, the longwall activity can be appraised in isolation or the total mining project, including infrastructure, major mine development and underground operations can be assessed. The approach adopted in this report lies between these two extremes, since the infrastructure is in place and major development has already been completed.

If the demonstration shows longwall mining to be viable then the equipment could be transferred to other panels within No. 9G-4 Mine adjacent to the demonstration area, for the remainder of its estimated 10 year useful life. Consequently, two project durations have been evaluated - a period of 5-years in which three demonstration panels would be worked and a 10-year period in which a total of 8 panels would be worked.

The costs and economic analyses are based upon:

- production rates shown in Table 6-2 column 3,
- manpower levels shown in Table 6-4 and
- development and production schedules shown in Figures 6-3 and 9-2.

Figure 9-1 shows the proposed mining layout for the extended operation.

CAPITAL COSTS

The capital already expended to access the reserves in the 9G-4 Mine is not included in the analysis performed. Only the capital costs directly related to the development for and the operation of the longwall are considered.

Where appropriate suitable equipment from within the existing pool at Smoky River has been allocated and charged to the project at 1/3 of its replacement capital cost. Capital costs also include additional equipment, replacement items, major overhauls and exploration.

The total capital expenditure required for the demonstration period is estimated to be $19.2 million (Table 9-1) and for the extended operation $26.2 million (Table 9-2).

A summary of capital expenditures is shown in (Table 9-3).

OPERATING COSTS

Operating costs are subdivided into three categories:

- Direct Mining Costs
- Non-Direct Costs
- Capital Charges and Regulatory Costs

Direct Mining Costs

These costs are associated with development, longwall mining and transportation of the coal to a mine-mouth stockpile. These costs include labour, mining materials, maintenance and power cost for both the development and longwall operation. The categories used at Smoky River are:

- Labour including supervision
- Electric power
- Mining materials
- Propane
- Maintenance; vehicle and mine.

Labour charges reflect negotiated contract rates and include all other charges associated with underground mining under this contract.

Development costs are based on actual costs incurred during recent activity at Smoky River. Where applicable, these costs have been derived as a standard cost for development and stated in dollars per raw ton.

For longwall, all costs other than mining materials have been derived from current operating data. Since mining material consumption data for longwall mining in Western Canada is not available, an estimate of $2 per raw ton has been used. This figure is believed to be more than adequate when viewed against the costs incurred at other similar longwall operations.

General mine maintenance costs are based on actual costs incurred during development and operation of the No. 9G-4 Mine. This cost includes both daily maintenance and major rebuilds. Longwall maintenance costs have been estimated from manufacturer's recommended maintenance schedules.

A detailed analysis of total direct mining costs for the demonstration (Table 9-4) shows a cost of $33.53 per raw ton at the mine-mouth in year 1, reducing to between $11.64 and $13.53 in years 2 through 5. This is due to the initial high ratio of development to longwall tonnage which is reversed as the project continues (Table 9-5). This results in a total operating cost of $14.4 million for the first year's production of 431,000 raw tons with $11.8 million attributed to development and $2.6 million to longwall. A further $4.7 million of expenditure will be incurred in years 2 and 3 for development. A cost of $11.1 million per year will be associated with the longwall operations from years 2 to 4 reducing to $5.7 million in the fifth year of the project.

For the extended operation, development work will continue each year. Initially three development teams will be deployed reducing to two teams for years 2 and 3. Three development teams will again be deployed in year 4 reducing to two teams for years 5 through 10.

Manpower levels in the extended operation are similar to those specified in the manpower deployment schedule for the demonstration period (Table 6-4) but with additional manpower to sustain development in years 4 to 10.

A detailed analysis of total direct mining costs for the extended operation (Table 9-6) shows a cost of $33.53 per raw ton at the mine-mouth in year 1 reducing to between $12.96 and $14.15 in years 2 through 10. The higher cost per raw ton in year 5 of the extended operation ($14.15) in comparison to the demonstration period ($11.64) reflects the increased development required to access the additional panels. The total operating cost for the first year's production of 431,000 raw tons is $14.4 million with $11.8 million attributed to development and $2.6 million to longwall operations. This will reduce to $13.3 million in years 5 through 10 with $2.6 million attributed to development and $10.7 million to longwall operations.

Non-Direct Cost

Non-direct costs are those costs associated with processing, transportation of the coal and administration. The costs which are unique to the Smoky River operation, have been provided to CANMET under confidential cover. These costs when added to the direct mining costs provide the basis for a complete analysis of the longwall operation and its effects on the economics of the Smoky River Mine.

Capital Charges and Regulatory Costs

These charges include depreciation, depletion, taxes and royalties and have been used for the calculations of pre-tax income provided to CANMET under separate cover.

CASH FLOW ANALYSIS

The estimated capital cost, direct and indirect operating costs and actual market price for Smoky River coal have been used to conduct a cash flow analysis for both the demonstration and extended operation periods. It was assumed that the capital expenditure required to procure the longwall equipment would be expended in the first year of operation with no special financial arrangements made.

These analyses show that apart from the first year of operation there is a positive cash flow in each succeeding year for both the demonstration and extended operation period.

The net present value of the cash flow during the demonstration period is satisfactory and is enhanced by the extended operation.

The effect of varying certain parameters on the net present value of cash flows has been assessed. This shows production level and coal sale price to be the most critical variables.

Detailed cash flow and sensitivity analyses have been provided to CANMET under separate cover.

PROCUREMENT FINANCING

Each tenderer suggested a method by which the longwall equipment capital cost could be financed to allow payment over an extended period.

The major benefit to be derived would be a reduction in the negative cash flow in the initial years of the project. Table 9-7 provides a summary of the alternative options offered.

RISK

The advanced status of the development of 9G-4 Mine and the configuration of the target reserve area reduces the overall risk associated with the investment in longwall. At a new mine, additional capital would be required to develop access to the reserve and the geology and geotechnical parameters of the reserve area would be less well known.

Should the longwall fail to achieve its projected production level Smoky River Coal Ltd. would face a substantial loss. However, if projected production levels can be consistently achieved, the financial risk should be limited and a reasonable rate of return on investment obtained.

CONCLUSIONS

Implementation of the longwall at Smoky River will displace other production capacity. The longwall must therefore achieve its planned production output levels throughout its life to ensure production commitments can be met.

While the risk associated with the project appears manageable, the project is unique to Western Canada and the total extent of the risk cannot be fully determined until a longwall mining system has been installed and operated.

McIntyre believe that the risk should be shared as the benefits to be gained from the longwall operation would be widespread and a unique opportunity to undertake meaningful research would be provided. The involvement of CANMET and other interested agencies to reduce the up-front capital required and the risk to the operator would enhance the potential for the implementation of a longwall demonstration project.

TABLE 9-1

CAPITAL COST DEMONSTRATION PERIOD (5-YEAR)

MAJOR PURCHASE SUMMARY

DESCRIPTION	REPLACEMENT VALUE (EACH)	NUMBER YEAR 1	REQUIRED YEAR 2-5	CAPITAL PER YEAR				
				YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
CONTINUOUS MINERS	650,000	4	2	430,000	430,000	430,000		
PROFILE HEADER MACHINES	750,000	0	1		750,000			
SHUTTLE CARS	125,000	6	4	167,000				
ROOF BOLTERS	120,000	6	4	167,000				
STAMLER FEEDERS	220,000	3	2	145,000				
AUXILIARY FANS	9,000	6	3			9,000		
PUMPS	5,000	3	3		5,000		5,000	
MATERIAL VEHICLES	240,000	3	3	240,00	160,000		160,000	
TRANSFORMERS	60,000	3	1	20,000				
SWITCHGEAR	14,000	26	8	37,000				
LIGHTENING TRANSFORMERS	7,000	2	1					
TELEPHONES	1,500	4	2					
HIGH TENSION SWITCHES	19,000	2	1	6,000				
CONVEYOR STRUCTURES & BELTS				827,000				
CONVEYOR DRIVES				100,000				
SUB TOTAL				2,152,000	1,345,000	439,000	165,000	
CONTINGENCY (15%)				323,000	202,000	66,000	25,000	
TOTAL CAPITAL DEVELOPMENT EQUIPMENT				2,475,000	1,547,000	505,000	190,000	
LONGWALL EQUIPMENT				12,500,000			2,000,000	
TOTAL CAPITAL				14,975,000	1,547,000	505,000	2,190,000	

TABLE 9-2

CAPITAL COSTS EXTENDED OPERATIONS (10-YEAR)

MAJOR PURCHASE SUMMARY

DESCRIPTION	REPLACEMENT VALUE (EACH)	NUMBER YEAR 1	REQUIRED YEAR 2-5	CAPITAL PER YEAR									
				YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
CONTINUOUS MINERS	650,000	4	2	430,000	430,000	430,000							
PROFILE HEADER MACHINES	750,000	0	2		750,000				750,000				
SHUTTLE CARS	125,000	6	4	167,000									
ROOF BOLTERS	120,000	6	4	167,000									
STAMLER FEEDERS	220,000	3	2	145,000									
AUXILIARY FANS	9,000	6	3			9,000							
PUMPS	5,000	3	3		5,000		5,000						
MATERIAL VEHICLES	240,000	3	3	240,00	160,000		160,000						
TRANSFORMERS	60,000	3	1	20,000									
SWITCHGEAR	14,000	26	8	37,000									
LIGHTENING TRANSFORMERS	7,000	2	1										
TELEPHONES	1,500	4	2										
HIGH TENSION SWITCHES	19,000	2	1	6,000									
CONVEYOR STRUCTURES & BELTS				827,000					376,000				
CONVEYOR DRIVES				100,000					100,000		100,000		
SUB TOTAL				2,152,000	1,345,000	439,000	165,000		1,226,000		100,000		
CONTINGENCY (15%)				323,000	202,000	66,000	25,000		184,000		15,000		
TOTAL CAPITAL DEVELOPMENT EQUIPMENT				2,475,000	1,547,000	505,000	190,000		1,410,000		115,000		
REPLACEMENT ITEMS							2,000,000		2,000,000		2,000,000		
LONGWALL EQUIPMENT				12,500,000									
EXPLORATION						500,000	500,000	500,000					
TOTAL INVESTMENT REQUIREMENTS FOR EXTENDED OPERATIONS				14,975,000	1,547,000	1,005,000	2,690,000	500,000	3,410,000		2,115,000		

TABLE 9-3

SUMMARY OF CAPITAL EXPENDITURE

	5 YEAR	10 YEAR
Longwall Face Equipment	12.5	12.5
Longwall Development Equipment	4.7	6.2
Replacement	2.0	6.0
Exploration	0	1.5
TOTAL	19.2	26.2

TAB -4

ANALYSIS OF DIRECT MINING COSTS
DEMONSTRATION PERIOD 5-YEARS

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
DEVELOPMENT COST (A)					
Labour	11.12	11.20	10.63	.00	.00
Electric Power	.58	.66	.66	.00	.00
Materials	8.24	8.24	8.24	.00	.00
	19.94	20,10	19.53		
LONGWALL FACE PRODUCTION COST (B)					
Labour	8.11	3.16	3.05	3.43	2.84
Electric Power	.15	.15	.15	.15	.15
Materials	2.00	2.00	2.00	2.00	2.00
	10.26	5.31	5.20	5.58	4.99
SHARED COSTS (C)					
Fixed Mine Cost	3.71	1.59	1.55	1.90	1.62
Propane	.34	.15	.14	.17	.15
Electric Power Fixed	.54	.23	.22	.27	.14
Other Labour	3.95	1.69	1.65	2.02	1.67
Staff and Supervision	3.92	1.68	1.60	1.86	1.59
SMC UG	3.39	1.45	1.41	1.73	1.48
	15.85	6.79	6.57	7.95	6.65
DIRECT MINING COST*	33.53	13.46	12.96	13.53	11.64

NOTE: All costs are provided on a dollars per long ton raw production basis.

$$* \text{ Direct Mining Cost} = \frac{\text{A x Development Tons + B x Longwall Tons + C x Total Tons}}{\text{Total Tons}}$$

TABLE 9-5

DEVELOPMENT AND LONGWALL PRODUCTION
BY YEAR - DEMONSTRATION PROJECT

YEAR	DEVELOPMENT		LONGWALL		TOTAL	
	LTR	LTC	LTR	LTC	LTR	LTC
1	330 021	239 265	100 510	72 870	430 531	312 135
2	92 157	66 814	913 330	662 164	1 005 487	728 978
3	85 902	62 279	948 290	687 510	1 034 192	749 789
4			843 410	611 472	843 410	611 472
5*			493 810	358 012	493 810	358 012
	508 080	368 358	3 299 350	2 392 028	3 807 430	2 759 756
PROPORTION BY SOURCE	13.3%		86.7%			

* Part year only.

TABLE

ANALYSIS OF DIRECT MINING COSTS
DEMONSTRATION PERIOD 10-YEARS

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5 - 10
DEVELOPMENT COST (A)					
Labour	11.12	11.20	10.63	10.63	10.58
Electric Power	.58	.66	.66	.66	.65
Materials	8.24	8.24	8.24	8.24	8.24
	19.94	20.10	19.53	19.53	19.47
LONGWALL FACE PRODUCTION COST (B)					
Labour	8.11	3.16	3.05	3.43	3.43
Electric Power	.15	.15	.15	.15	.15
Materials	2.00	2.00	2.00	2.00	2.00
	10.26	5.31	5.20	5.58	5.58
SHARED COSTS (C)					
Fixed Mine Cost	3.71	1.59	1.55	1.62	1.70
Propane	.34	.15	.14	.15	.16
Electric Power Fixed	.54	.23	.22	.23	.25
Other Labour	3.95	1.69	1.65	1.72	1.81
Staff and Supervision	3.92	1.68	1.60	1.59	1.67
SMC UG	3.39	1.45	1.41	1.48	1.55
	15.85	6.79	6.57	6.78	7.13
DIRECT MINING COST*	33.53	13.46	12.96	14.41	14.15

NOTE: All costs are provided on a dollars per long ton raw production basis.

$$* \text{ Direct Mining Cost} = \frac{\text{A x Development Tons + B x Longwall Tons + C x Total Tons}}{\text{Total Tons}}$$

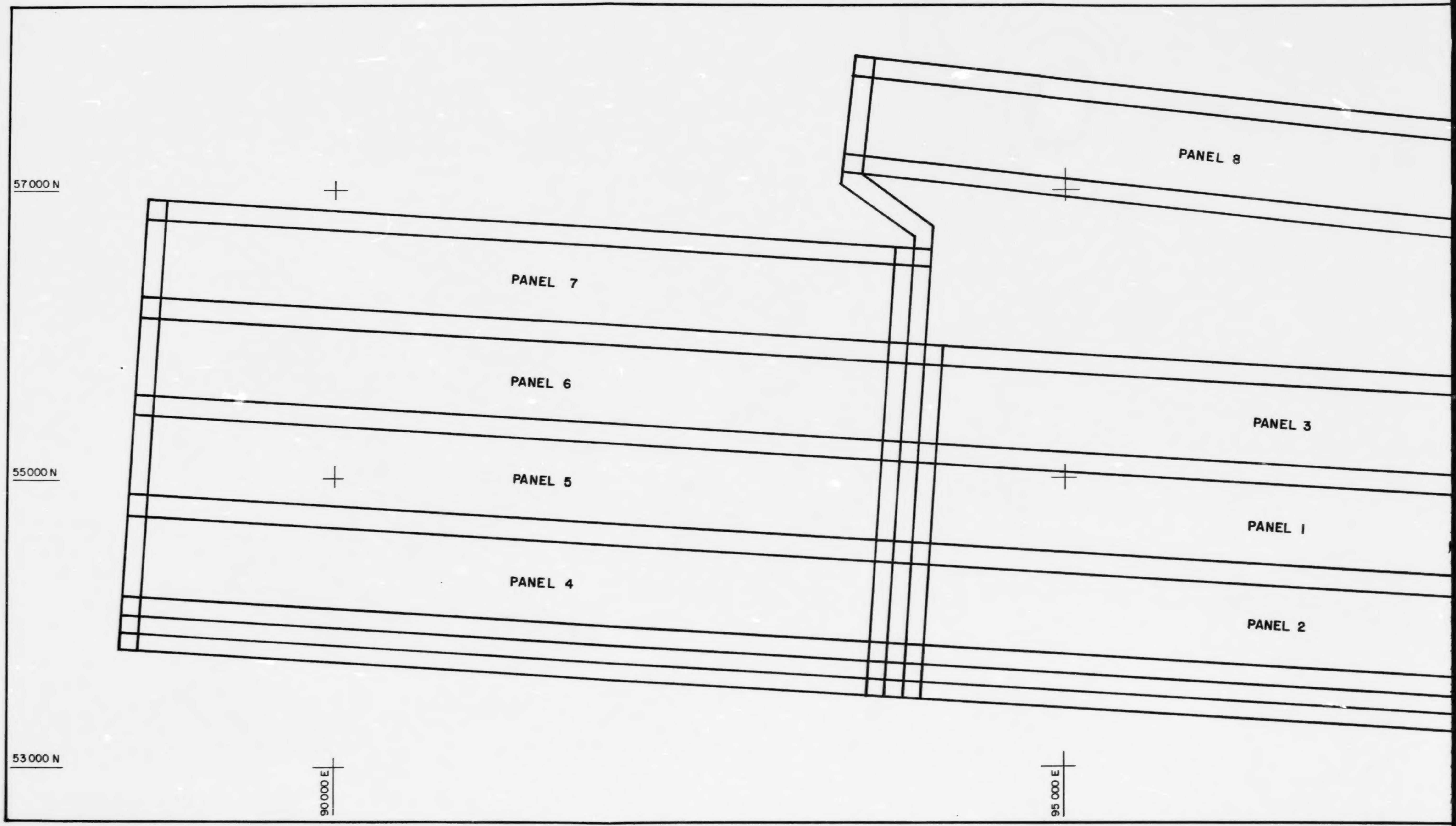
TABLE 9-7

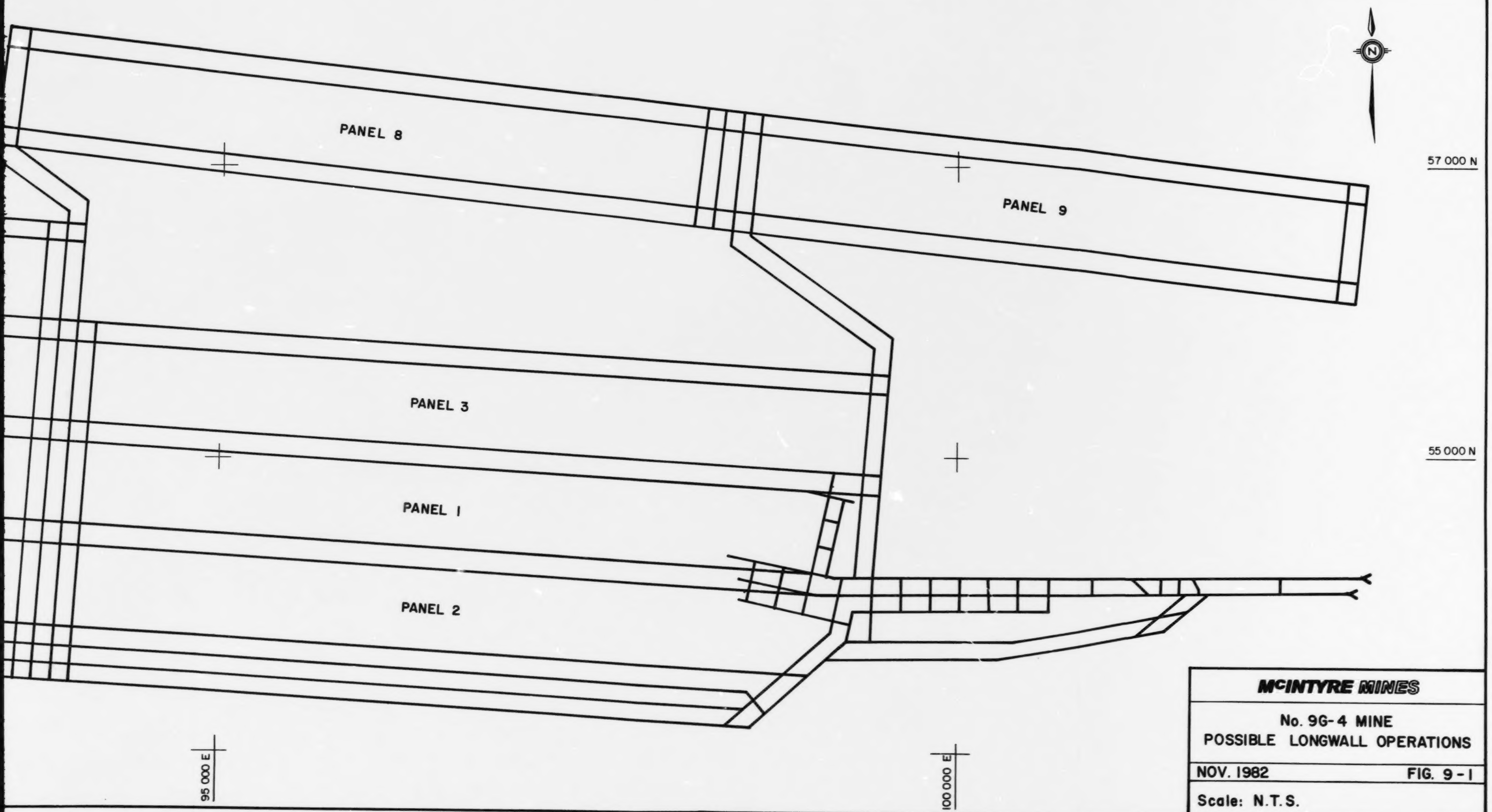
SUMMARY OF ALTERNATIVE PROCUREMENT FINANCING ARRANGEMENTS

NOTE: Option 1: 5% with order, 10% upon shipment, 85% in 10 equal semi-annual payments. Interest rate = 12.15%

Option 2: 10% with order, 10% upon shipment, 80% in 10 equal semi-annual payments. Interest rate 9%. Note: Financial arrangements cover materials manufactured in country of origin. Requires payment in designated currency.

Option 3: Based on 5-year lease options provided. Total equipment cost recovered in this period and equipment can then be purchased outright for $1.


57000 N
55000 N
53000 N
90000 E
95000 E
PANEL 8
PANEL 7
PANEL 6
PANEL 5
PANEL 4
PANEL 3
PANEL 1
PANEL 2


PANEL 8
PANEL 9
PANEL 3
PANEL 1
PANEL 2
N
57 000 N
55 000 N
95 000 E
100 000 E

McINTYRE MINES

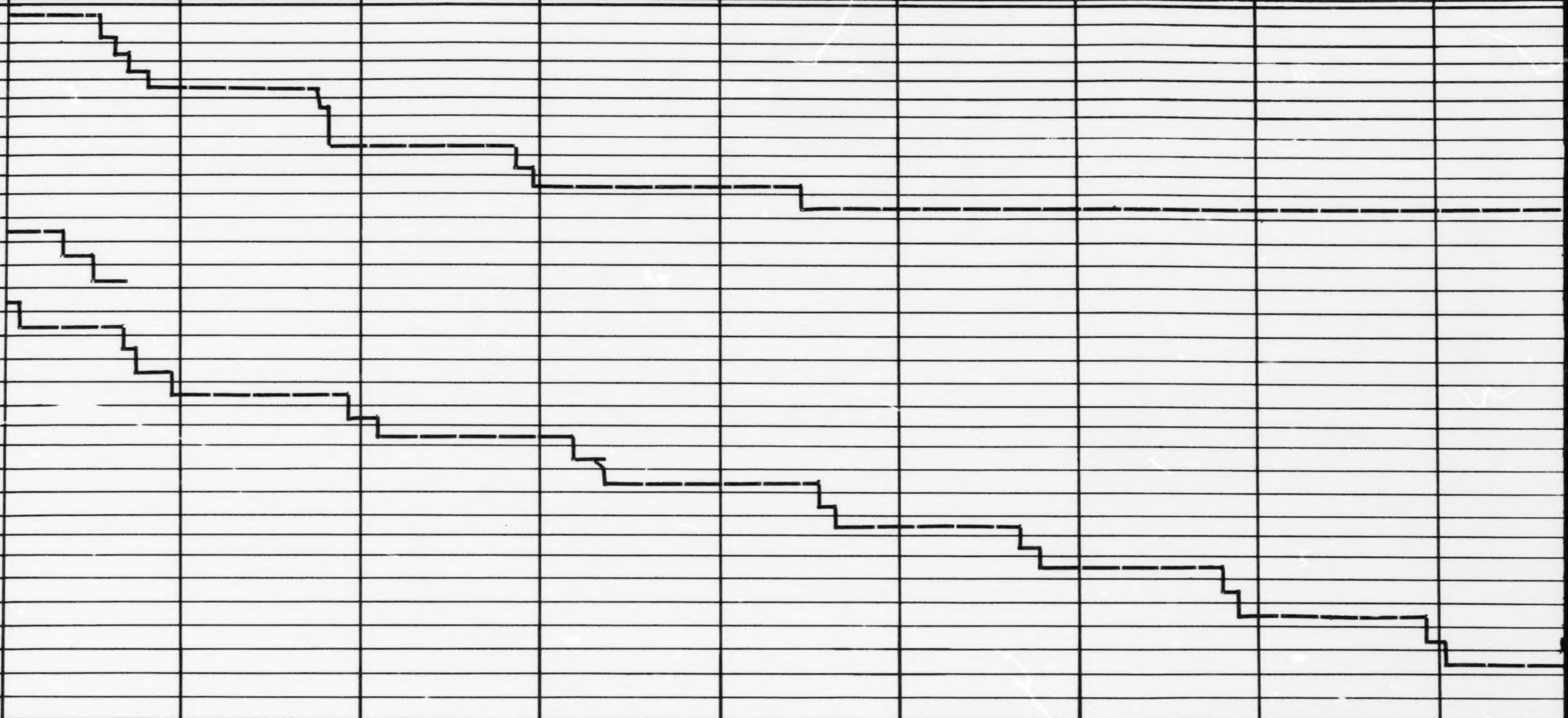
No. 9G-4 MINE
POSSIBLE LONGWALL OPERATIONS

NOV. 1982

FIG. 9 - 1

Scale: N.T.S.

YEARS	MANNING	SHIFTS DAILY	1	2	3	4	5	6	7	8	9
DAYS			233	466	699	932	1165	1398	1631	1864	2097
No. 1 Panel L.H. Roads	33	3									
No. 2 Face to Anticline	33	3									
Transfer Equipment	33	3									
South Development	22	2									
No. 2 Panel L.H. Roads	22	2									
Transfer Equipment	22	2									
Men Re-Deployed											
No. 3 Panel R.H. Roads	22	2									
No. 3 Face Development	22	2									
Development of Additional	33	3									
Panels	22	2									
No. 3 and 4 Entries	33	3									
North Development No. 2	33	3									
Power Centre	33	3									
North Development No. 1	33	3									
No. 1 Panel R.H. Roads	33	3									
No. 1 Panel Face	33	3									
Installation	66	3									
No. 1 Face Production	63	3									
Transfer Equipment	63	3									
No. 2 Face Production	63	3									
Transfer Equipment	63	3									
No. 3 Face Production	63	3									
Transfer Equipment	63	3									
No. 4 Face Production	63	3									
Transfer Equipment	63	3									
No. 5 Face Production	63	3									
Transfer Equipment	63	3									
No. 6 Face Production	63	3									
Transfer Equipment	63	3									
No. 7 Face Production	63	3									
Transfer Equipment	63	3									
No. 8 Face Production	63	3									



		1	2	3	4	5	6	7	8	9
LONGWALL	(L.T.R.)	—	—	—	843,410	843,410	843,410	843,410	843,410	843,41
DEVELOPMENT	(L.T.R.)	430,531	1,005,487	1,034,192	145,625	97,568	97,568	97,568	97,568	97,56
TOTAL	(L.T.R.)	430,531	1,005,487	1,034,192	989,035	940,978	940,978	940,978	940,978	940,97
	(L.T.C.)	312,135	728,978	747,789	717,050	682,209	682,209	682,209	682,209	682,20

McINT

DEVELOPMENT
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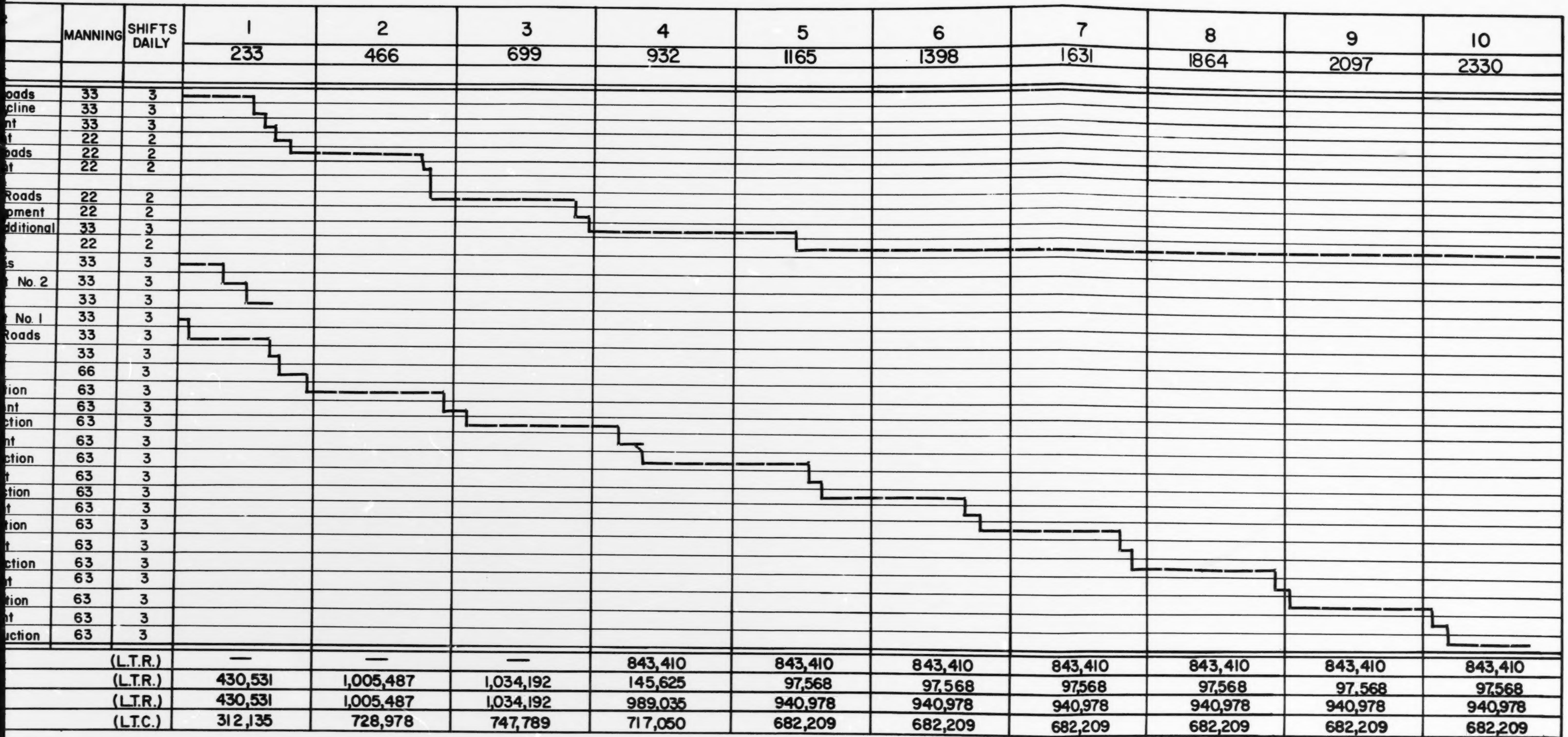
10-Y

NOV. 1982

Scale: N.T.S.



	MANNING	SHIFTS DAILY	1	2	3	4	5	6	7	8	9	10
			233	466	699	932	1165	1398	1631	1864	2097	2330
oads	33	3										
cline	33	3										
nt	33	3										
t	22	2										
oads	22	2										
t	22	2										
Roads	22	2										
pment	22	2										
dditional	33	3										
	22	2										
s	33	3										
No. 2	33	3										
	33	3										
No. 1	33	3										
Roads	33	3										
	33	3										
	66	3										
tion	63	3										
nt	63	3										
ction	63	3										
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nt	63	3										
uction	63	3										
		(L.T.R.)	—	—	—	843,410	843,410	843,410	843,410	843,410	843,410	843,410
		(L.T.R.)	430,531	1,005,487	1,034,192	145,625	97,568	97,568	97,568	97,568	97,568	97,568
		(L.T.R.)	430,531	1,005,487	1,034,192	989,035	940,978	940,978	940,978	940,978	940,978	940,978
		(L.T.C.)	312,135	728,978	747,789	717,050	682,209	682,209	682,209	682,209	682,209	682,209

McINTYRE MINES

DEVELOPMENT AND PRODUCTION
SCHEDULE
10-YEAR PLAN

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FIG. 9-2

Scale: N.T.S.

POOR

QUALITY

ORIGINAL